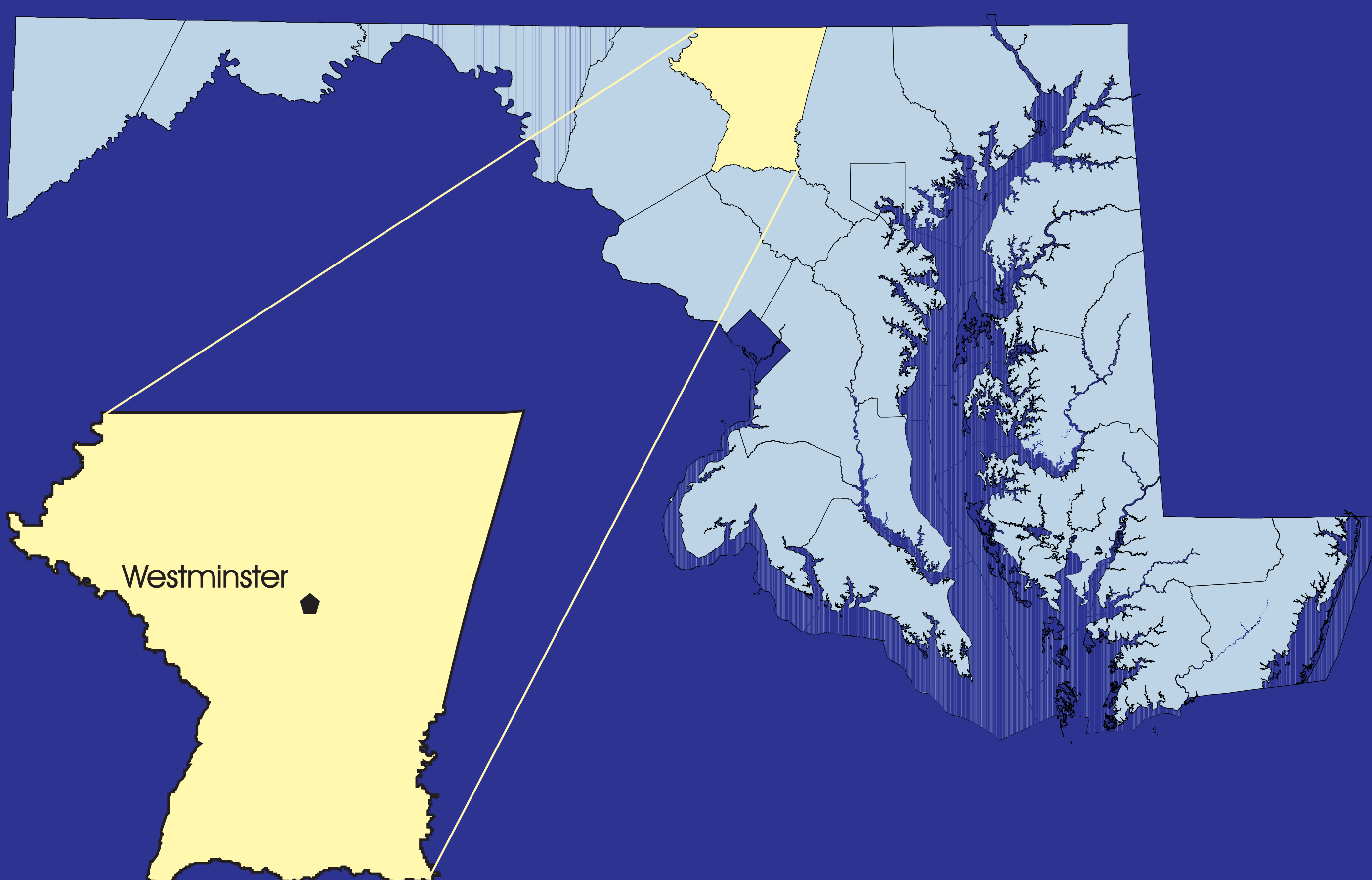
CARROLL COUNTY

RESULTS OF THE 1994-1997 MARYLAND BIOLOGICAL STREAM SURVEY: COUNTY ASSESSMENTS



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CARROLL COUNTY

Results of the 1994-1997 Maryland Biological Stream Survey: County-Level Assessments

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December 2001

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FOREWORD

This report is based on results of the Maryland Biological Stream Survey (MBSS), a program funded primarily by the Power Plant Research Program and administered by the Maryland Department of Natural Resources (MDNR). Field data for the MBSS were collected by the Maryland Department of Natural Resources. Analyses of water chemistry samples were conducted by the University of Maryland's Appalachian Laboratory. Much of the initial data analysis was conducted by Versar, Inc. for MDNR's Power Plant Assessment Division.

This report helps fulfill two outcomes in MDNR's Strategic Plan: 1) A Vital and Life Sustaining Chesapeake Bay and Its Tributaries, and 2) Sustainable Populations of Living Resources and Healthy Ecosystems.

ACKNOWLEDGMENTS

The 1994-1997 Maryland Biological Stream Survey has been a cooperative effort among several agencies, consultants and academic institutions. We wish to thank Nancy Roth and Ginny Mercurio from Versar in helping to compile some of the data used in this report. Versar also designed the sampling program, obtained landowners' permissions, and helped manage the data. We are also grateful to the many individuals from Maryland Department of Natural Resources, the University of Maryland's Appalachian Laboratory (AL), and the University of Maryland's Wye Research and Education Center (WREC) who comprised the field crews and did a great job collecting the data. MDNR staff also digitized watersheds and calculated land use data, provided quality assurance, and conducted field crew training. Nancy Roth and her colleagues at Versar developed the fish Index of Biotic Integrity, and Dr. Sam Stribling and his staff at Tetra Tech, Inc. developed the benthic Index of Biotic Integrity. Dr. Ray Morgan of AL and Mr. Lenwood Hall of the WREC supervised additional field crews and developed the Physical Habitat Index, and Dr. Keith Eshleman of AL assisted with analyses of data on acidified streams. Drs. Wayne Starnes and Bob Reynolds of the Smithsonian Institution (reptiles and amphibians), Dr. Rich Raesly of Frostburg State University (fish), Rita Villella of the U.S. Geological Survey Leetown Science Center (mussels), and Michael Naylor of MDNR (aquatic vegetation) provided taxonomic verifications of voucher specimens. The success of the project resulted from the strong efforts of all these groups. Special thanks go to Ron Klauda for his editorial support and Brenda Morgan for her assistance in formatting, editing, and organizing the report.

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INTRODUCTION

This report presents county-level data from the 1994-1997 Maryland Biological Stream Survey (MBSS or the Survey). Previous reports have documented interim results from the 1995 (Roth et al. 1997) and 1996 (Roth et al. 1998a) sample years. In addition, a comprehensive final report was produced to assess the "state of the streams" throughout the state (Roth et al. 1999). All previous MBSS reports have presented information by individual drainage basins. Because there is a recognized need for stream health information at the county level, a series of reports were prepared; this report is part of that series. This introductory section recounts the origin of the Survey and describes its components.

Origin of the MBSS

More than 10 years ago, the Maryland Department of Natural Resources (MDNR) recognized that atmospheric deposition was one of the most important environmental problems resulting from the generation of electric power. To determine the extent of acidification of Maryland streams resulting from acidic deposition, MDNR conducted the Maryland Synoptic Stream Chemistry Survey (MSSCS) in 1987. The MSSCS estimated the number and extent of streams at that time affected by or sensitive to acidification statewide and demonstrated the potential for adverse effects on biota from acidification. However, little direct information was available on the biological responses of Maryland streams to water chemistry conditions. Data that were available could not be used (because of methodological differences and spatial coverage limitations) to compare conditions across regions or watersheds (Tornatore et al. 1992). Neither was it possible to assess the interactions between acidic deposition and other anthropogenic and natural influences (CBRM 1989). For these reasons, in 1993, MDNR created the MBSS to provide comprehensive information on the status of biological resources in Maryland streams and how they are affected by acidic deposition and other cumulative effects of anthropogenic stresses.

Description of the MBSS

The MBSS is intended to help environmental decision-makers protect and restore the natural resources of Maryland. The primary objectives of the MBSS are:

- to assess the current status of biological resources in Maryland's non-tidal streams;
- to quantify the extent to which acidic deposition has affected or may be affecting biological resources in the state;
- to examine which other water chemistry, physical habitat, and land use factors are important in explaining the current status of biological resources in streams;
- to compile the first statewide inventory of stream biota;
- to establish a benchmark for long-term monitoring of trends in these biological resources; and
- to target future local-scale assessments and mitigation measures needed to restore degraded biological resources.

In creating the Survey, MDNR implemented a probability-based sampling design as a cost-effective way to characterize statewide stream resources. By randomly selecting sites, the Survey can make quantitative inferences about the characteristics of all 9,258 miles of first-to-third-order, non-tidal streams in Maryland (based on stream length on a 1:250,000-scale base map). MDNR recognized that the utility of these estimates depended on accurately measuring appropriate attributes of streams. The Survey focuses on biology for two reasons: (1) organisms themselves have direct societal value and (2) biological communities integrate stresses over time and are a valuable and cost-effective means of assessing ecological integrity (i.e., the capacity of a resource to sustain its inherent potential).

Fish are an important component of stream integrity and one that also contributes to substantial recreational values. For these reasons, fish communities are a primary focus of the Survey. The Survey collects quantitative data for the calculation of population estimates for individual fish species (both game and nongame). These data can also be used to evaluate fish community composition, individual fish health, and the geographic distribution of commercially important, rare, or non-indigenous fish species. Benthic (bottom-dwelling) macroinvertebrates are another essential component of streams and they constitute the second principal focus of the Survey. The Survey uses rapid bioassessment procedures for collecting benthic macroinvertebrates; these semi-quantitative methods permit comparisons of relative abundance and community composition, and have proven to be an effective way of assessing biological integrity in streams (Hilsenhoff 1987, Lenat 1988, Plafkin et al. 1989, Kerans and Karr 1994, Resh 1995). The Survey also records the presence of reptiles and amphibians (herpetofauna), freshwater mussels, and aquatic plants (both submerged aquatic vegetation (SAV) and emergent macrophytes). The Survey has established rigorous protocols (Kazyak 1996) for each of these sampling components, as well as training and auditing procedures to assure that data quality objectives are met.

Although the MBSS sampling design and protocols provide exceptional information for characterizing the stream resources in Maryland, designation of degraded areas and identification of likely stresses requires additional activities. Assessing the condition of biological resources (whether they are degraded or not degraded) requires the development of ecological indicators that permit the comparison of sampled segment results to minimally impacted reference conditions (i.e., the biological community expected in watersheds with little or no human-induced impacts). The Survey has used its growing database of information collected with consistent methods and broad coverage across the state to develop and test indicators of individual biological components (Stribling et al. 1998, Roth et al. 1998b) and physical habitat quality (Hall et al. 1999). Each of these indicators consists of multiple metrics using the general approach developed for the Index of Biotic Integrity (IBI) (Karr et al. 1986, Karr 1991) and the Chesapeake Bay Benthic Restoration Goals (Ranasinghe et al. 1994). The fish and benthic macroinvertebrate IBIs (which combine attributes of both the number and the type of species found) are widely accepted indicators that have been adapted for use in a variety of geographic locations (Miller et al. 1988, Cairns and Pratt 1993, Simon 1999). The Survey is investigating the possibility of developing additional indicators (e.g., amphibians in small streams with few or no fish) and combining components into a composite indicator of biological integrity.

In addition to developing reference-based indicators, the Survey is applying a variety of analytical methods to the question of which stressors are most closely associated with degraded streams. This involves correlational and multivariate analyses of water chemistry, physical habitat, land use, and biological information (e.g., presence of non-native species). The biological information also provides a valuable opportunity for documenting aquatic biodiversity across the state; the distribution and abundance of species previously designated as rare only by anecdotal evidence can be determined, and unique combinations of species at the ecosystem and landscape levels can be identified. Land use and other landscape-scale metrics will play an important role in identifying the relative contributions of different stressors to the cumulative impact on stream resources. Ultimately, the Survey seeks to provide an integrated assessment of the problems facing Maryland streams that will facilitate interdisciplinary solutions for their restoration. The survey also provides resource managers with the locations of relatively undisturbed streams and watersheds that deserve protection.

METHODS

This section presents the specific study design and procedures used to implement the Maryland Biological Stream Survey. The study area of concern and the sampling design developed to characterize it are presented, along with field and laboratory methods for each component: fish, benthic macroinvertebrates, reptiles and amphibians, physical habitat, and water chemistry. Methods for aquatic vegetation and mussel sampling are presented, but the resulting data are not included in this report. A full description of MBSS methods can be found in Kazyak (1996).

MBSS Study Design

The Survey study area comprises 17 distinct drainage basins across the state. Random sampling was used to allow the estimation of unbiased summary statistics (e.g., means, proportions, and their respective variances) for the entire state, a particular basin, and subpopulations of interest (e.g., streams with pH < 5).

Because it would have been cost prohibitive to visit a sufficient number of sites in all basins in a single year, lattice sampling was used to schedule sampling of all basins over a three-year period, 1995-1997. Lattice sampling, also known as multistratification, is a cost-effective means of allocating effort across time in a large geographic area (Heimbuch 1999, Jessen 1978, Cochran 1977). A table, or lattice, was formed by arranging 17 basins in 17 rows, and the years in 3 columns. Lattice sampling was the method used for selecting cells from this 17x3 table so that all basins would be sampled over a three-year period and all basins would have a non-zero probability of being sampled in a given year. Although included as one of the basins in the original design, the Conewago basin was not sampled as part of the Survey's random sampling, because its small number of non-tidal stream miles would not permit accurate estimates of basin characteristics. However, in 1997, three sites chosen in a non-random manner in the Conewago basin were sampled using MBSS methods. The data presented in this report include those collected at random sampling sites within the 17 principal basins in Maryland, the non-random sites of the Conewago basin, and sites from the 1994 demonstration project. Because no estimates were calculated for this report, these data were included to supplement the number of sites.

The sampling frame for the Survey was constructed by overlaying basin boundaries on a map of all blue-line stream reaches in the study area as digitized on a U.S. Geological Survey 1:250,000 scale topographic map. This sample frame was similar to that used by the earlier Maryland Synoptic Stream Chemistry Survey (MSSCS) conducted in 1987 (Knapp and Saunders 1987, Knapp et al. 1988). The Strahler convention (Strahler 1957) was used for ranking stream reaches by order; first-order reaches, for example, are the most upstream reaches in the branching stream system. Sampling was restricted to non-tidal, third-order and smaller stream reaches, excluding impoundments that were non-wadable or that substantially altered the riverine nature of the reach (Kazyak 1994). Together, these first-through third-order streams comprise about 90% of all stream and river miles in Maryland. Stream reaches were further divided into non-overlapping, 75-meter segments; these segments were the elementary sampling units from which biological, water chemistry, and physical habitat data were collected.

The 1995-1997 MBSS study design was based on stratified random sampling of segments within each basin; each basin was stratified by stream order. Within a stream order, the number of segments sampled per basin is proportional to the number of stream miles in the basin. To achieve the target number of samples per stream order within each basin, a given number of segments were randomly selected from each basin and ranked in order of selection. In all basins, extra segments were selected as a contingency against loss of sampling sites from restricted access to selected streams or from streams that were dry, too deep, or otherwise unsampleable owing to field conditions. In some basins, where only a small number of sites would have been selected using this method, additional random sites were selected to increase sample size. These extra sites (selected at random using the method described above) were used to provide better basinwide estimates; they were not included in the estimates of statewide conditions.

Permissions were obtained to access privately owned land adjacent to or near each stream segment. The procedures for obtaining permissions are described in Chaillou (1995). Because landowner permissions were obtained in a synoptic fashion and some variation in these rates occurred, we obtained more permissions than were needed for the Survey. Only the highest ranking sites were sampled until the target goal for that basin was reached. For the three year study, the success rate for obtaining permission to access stream sampling segments was high. Eighty-eight percent of sites that were targeted for permission were sampled. Reasons for permission denial varied and generally reflected the preferences of landowners regarding property access, rather than any specific types of land. In rare cases, permission denial may affect the interpretation of Survey estimates, but only where denials occur in streams with characteristics that differ from the general population of streams. In one example of potential bias, several sites with known coal mining activities in the North Branch Potomac basin denied permission to sample, likely under representing the proportion of acid mine drainage streams in the population.

Field and Laboratory Methods

Benthic macroinvertebrate and water quality sampling were conducted in spring, when the benthos are thought to be reliable indicators of environmental stress (Plafkin et al. 1989) and when acid deposition effects are often the most pronounced. Fish, reptiles and amphibians, aquatic vegetation, and mussel sampling, along with physical habitat evaluations, were conducted during the low-flow period in summer. Fish community composition tends to be stable during summer, and low flow is advantageous for electrofishing. Because low-flow conditions in summer may be a primary factor limiting the abundance and distribution of fish populations, habitat assessments were performed during the summer. The sample size in summer is lower than in spring because some streams were dry in summer or were, in rare cases, otherwise unsampleable.

To reduce temporal variability, sampling during spring and summer was conducted within specific, relatively narrow time intervals, referred to as index periods (Janicki et al. 1993). These index periods were defined by degree-day limits for specific parts of the state. This approach provided a synoptic assessment of the current status of stream biota, water quality, and physical habitat in the 17 basins sampled. The spring index period was the time period between approximately March 1 and May 1, with end of the index period determined by degree-day accumulation as specified in Hilsenhoff (1987). In reality, most spring samples (78%) were collected in March, well before degree-day accumulation limits were approached. The summer index period was between June 1 and September 30 (Kazyak 1994).

Data Collection and Measurement

Field sampling followed procedures specified in the MBSS sampling manual (e.g., Kazyak 1996). A summary of the variables measured and the field and laboratory methods used to conduct the sampling follows.

Fish

Fish were sampled during the summer index period using double-pass electrofishing within 75-meter stream segments. Block nets were placed at each end of the segment and direct current backpack electrofishing units were used to sample the entire segment. An attempt was made to thoroughly fish each segment, and consistent effort was applied over the two passes. This sampling approach allowed calculation of several metrics useful in calculating a biological index and produced unbiased estimates of fish species abundance.

In small streams, a single electrofishing unit was used. In larger streams, two to five units were employed to effectively sample the site. Captured fish were identified to species, counted, weighed, and released. Any individuals that could not be identified to species were retained for laboratory confirmation. For each pass, all individuals of each gamefish species (defined as trout, bass, walleye, pike, chain pickerel, and striped bass) were measured for total length and examined for visible external pathologies or anomalies. For nongame species, up to 100 fish of each species (from both passes) were examined for visible external pathologies or anomalies. For each pass, all non-game species were weighed together for an aggregate biomass measurement; gamefish were also weighed in aggregate to the nearest 10 g.

Electrofishing was also conducted at supplemental, non-randomly selected sites during the summer index period. The presence of each species of fish was recorded for these segments to provide additional qualitative information on statewide fish distributions. Sampling effort at most qualitative sites was based on doubling the elapsed time since the last species was recorded or a minimum of 600 seconds of electrofishing effort.

After processing the fish collected in the field, voucher specimens were retained for each species not previously collected in the drainage basin. In addition, all individuals which could not be positively identified in the field were retained. The remaining fish were released. All voucher specimens and fish retained for positive identification in the laboratory were examined and verified by the MBSS Quality Assurance Officer or ichthyologists at Frostburg State University, Frostburg, Maryland or the Smithsonian Institution, Washington, DC.

Benthic Macroinvertebrates

Benthic macroinvertebrates were collected to provide a qualitative description of the community composition at each sampling site (Kazyak 1996). Sampling was conducted during the spring index period. Benthic community data were collected for the purpose of calculating biological metrics, such as those described in EPA's Rapid Bioassessment Protocols (Plafkin et al. 1989), and use as an indicator of biological integrity for Maryland streams.

At each segment, a 600 micron mesh "D" net was used to collect organisms from habitats likely to support the greatest taxonomic diversity. A riffle area was preferred, but other habitats were also sampled using a variety of techniques including kicking, jabbing, and gently rubbing hard surfaces by hand to dislodge organisms. If available, other habitat types were sampled, including rootwads, woody debris, leaf packs, macrophytes, and undercut banks. Each jab covered one square foot, and a total of approximately 2.0 m^2 (20 square feet) of combined substrates was sampled and preserved in 70% ethanol. In the laboratory, the preserved sample was transferred to a gridded pan and organisms were picked from randomly selected grid cells until the cell that contained the 100th individual (if possible) was completely picked. Some samples had fewer than 100 individuals. The benthic macroinvertebrates were identified to genus, or lowest practicable taxon, in the laboratory.

Index of Biotic Integrity

Sites were evaluated using both the fish (F-IBI) and benthic macroinvertebrate (B-IBI) IBIs developed for the MBSS (for detailed methods, see Roth et al. 1997 and Stribling et al. 1998). IBI scores for the MBSS are determined by comparing the fish or benthic macroinvertebrate assemblages at each site to those found at minimally impacted reference sites. Three separate formulations were employed for the fish IBI, one for each of three distinct geographic areas: Coastal Plain, Eastern Piedmont, and Highland. The two formulations used for the benthic IBI cover the Coastal Plain and non-Coastal Plain regions. Individual metrics for the IBI are scored 1, 3, or 5, based on comparison with the distribution of metric values at reference sites. For either the individual metrics or total IBI, a score of 3 or greater is considered comparable to reference site conditions, while scores falling below this threshold differ significantly from the reference conditions. Scores for the MBSS IBIs are calculated as the mean of the individual metric scores and therefore range from 1 to 5. Some other programs have used a similar approach (e.g., Weisberg et al. 1997), while others have instead computed the IBI as the total of individual metric scores. For example, Karr et al. (1986) calculated IBI as the sum of 12 metric scores, with totals ranging from 12 to 60 points.

Reptiles and Amphibians

At each sample segment, reptiles and amphibians were identified and the presence of observed species was recorded during the summer index period. A search of the riparian area was conducted within 5 meters of the stream on both sides of the 75-meter segment. Any reptiles and amphibians collected during the electrofishing of the stream segment were also included in the species list. Individuals were identified to species when possible. Voucher specimens and individuals not positively identifiable in the field were retained for examination in the laboratory and confirmation by herpetologists at the Smithsonian Institution, Washington, DC, or Towson University, Towson, Maryland.

Physical Habitat

Habitat assessments were conducted at all stream segments as a means of assessing the importance of physical habitat to the biological integrity and fishability of freshwater streams in Maryland. Procedures for habitat assessments (Kazyak 1996) were derived from two currently used methodologies: EPA's Rapid Bioassessment Protocols (RBPs) (Plafkin et al. 1989), as modified by Barbour and Stribling (1991), and the Ohio EPA's Qualitative Habitat Evaluation Index (QHEI) (Ohio EPA 1987, Rankin 1989). A number of characteristics (instream habitat, epifaunal substrate, velocity/depth diversity, pool/glide/eddy quality, riffle/run quality, channel alteration, bank stability, embeddedness, channel flow status, and shading) were assessed qualitatively, based on visual observations within each 75-meter sample segment. Riparian zone vegetation width was estimated to the nearest meter, up to 50 meters from the stream. Additional observations of the surrounding area were used to assign ratings for aesthetic value (based on visible signs of human refuse at a site) and remoteness (based on distance from the nearest road, accessibility, and evidence of human activity). Also recorded were the presence or absence of various stream features including substrate types, various morphological characteristics, beaver ponds, point sources, and stream channelization. Local land uses visible from the stream segment and riparian vegetation type were also noted. Several additional physical characteristics were measured quantitatively to further characterize the habitat for each segment (see Kazyak 1996 for details). Quantitative measurements of the segment included maximum depth, stream gradient, velocity, thalweg depth, number of functional rootwads, number of functional large woody debris, wetted width, sinuosity, and overbank flood height. A velocity/depth profile was measured or other data were collected to enable calculation of discharge.

Physical Habitat Index

The Physical Habitat Index (PHI) was developed using MBSS data from 1994 to 1997 (Hall et al. 1999). As was the case in development of the fish and benthic IBIs, the conceptual approach was based on evaluating the relative importance (discriminatory power) of individual metrics and combinations of metrics explaining natural differences in streams throughout Maryland. These metrics were derived from both quantitative and qualitative habitat data collected during the summer index period. Based on analyses conducted for both fish IBI (Roth et al. 1998) and benthic macroinvertebrate IBI (Stribling et al. 1998) development in Maryland, the State was divided into two regions: the Coastal Plain and non-Coastal Plain. The resulting index was then adjusted to a centile scale that rated each sample segment as follows: Good - 72 to 100; Fair - 42 to 71.9; Poor - 12 to 41.9; and Very Poor - 0 to 11.9.

Water Chemistry

During the spring index period, water samples were collected at each site for analysis of pH, acid neutralizing capacity (ANC), conductivity, sulfate, nitrate-nitrogen, and dissolved organic carbon (DOC). These variables describe basic water quality conditions with an emphasis on factors related to acidic deposition.

Grab samples were collected in one-liter bottles for analysis of all analytes except pH. Water samples for pH were collected with 60 ml syringes, which allowed purging of air bubbles to minimize changes in carbon dioxide content (EPA 1987). Samples were stored on wet ice and shipped on wet ice to the analytical laboratory within 48 hours. Laboratory analyses were carried out by the University of Maryland's Appalachian Laboratory in Frostburg.

Chemical analysis of water samples followed standard methods described in EPA's Handbook of Methods for Acid Deposition Studies (EPA 1987). EPA protocols were followed, except that ANC sample volume was reduced to 40 ml to ease handling. Routine daily quality control (QC) checks included processing duplicate, blank, and calibration samples according to EPA guidelines for each analyte. Field duplicates were taken at 5% of all sites. Routine QC checks helped to identify and correct errors in sampling routines or instrumentation at the earliest possible stage.

During the summer index period, in situ measurements of dissolved oxygen (DO), pH, temperature, and conductivity were collected at each site to further characterize existing water quality conditions that might influence biological communities. Measurements were made at an undisturbed section of the segment, usually in the middle of the stream channel, using electrode probes. Instruments were calibrated daily and calibration logbooks were maintained to document instrument performance.

Recognizing that water temperature is an important factor affecting stream condition, but one that varies daily and seasonally, temperature loggers were deployed at 220 sites in five basins during 1997. The basins sampled were: the Choptank, Susquehanna, Potomac Washington Metro, Patuxent, and Pocomoke. Onset Computer Corporation Optic Stowaway temperature loggers were anchored in each site during the summer index period. Water temperature was recorded every 15 minutes from June 15 until mid-September.

Mussels

During the summer index period, freshwater mussels were sampled qualitatively by examining each 75-meter stream segment for their presence. Mussels were identified to species, their presence recorded, and released. Species not positively identifiable in the field were retained for confirmation by U.S. Geological Survey (USGS) Biological Resources Division staff.

Aquatic Vegetation

Aquatic vegetation was sampled qualitatively by examining each 75-meter segment for the presence of aquatic plants. Plants were identified to species and their presence recorded for each site. While the primary objective was to document the presence of submerged aquatic vegetation (SAV), emergent and floating aquatic vegetation was also recorded when encountered. Species not positively identifiable in the field were retained for laboratory examination and confirmation by MDNR's staff expert on SAV. Due to the difficulty in long-term preservation, no permanent vouchers of aquatic vegetation were retained.

Data Management

All crews used standardized pre-printed data forms developed for the Survey to ensure that all data for each sampling segment were recorded and standard units of measure were used (Kazyak 1996). Using standard data forms facilitated data entry and minimized transcription error. The field crew leader and a second reviewer checked all data sheets for completeness and legibility before leaving each sampling location. Original data sheets were sent to the Data Management Officer for further review and data entry, while copies were retained by the field crews.

A custom database application, in which the input module was designed to match each of the field data sheets, was used for data entry. Data were independently entered into two databases and compared using a computer program as a quality-control procedure. Differences between the two databases were resolved from original data sheets or through discussions with field crew leaders.

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Maryland Biological Stream
Survey Data

COUNTY SUMMARY

A total of 98 sites were sampled in Carroll county by MBSS sampling crews during the 1994-1997 sampling season (Table 1; Figure 2). Qualitative fish sampling was conducted at an additional 39 sites to provide a more complete picture of fish species distributions. Appendix A provides a summary of the types of data available for each of the sites sampled.

Species Highlights

A total of 44 fish species were collected in the small to mid-sized streams that were sampled; this number ranks Carroll among the upper third of counties in the state. Consistent with other areas of the state, only a small percentage (5%) of the sites sampled contained no fish (Table 2). The 198 genera of benthic macroinvertebrates found in Carroll county ranks it third in the state. However, 30% of these taxa were found at a single site (1% occurrence) and many appear to be rare on a statewide basis (Table 3).

Blacknose dace, creek chub, and white sucker, all pollution-tolerant species, were the most commonly found fish during the 1994-1997 sampling period (Table 2). In contrast, pollution-sensitive brook trout, once found in streams throughout Carroll county, were found at only 1% of the streams sampled by the MBSS. No state or federally listed fish species were collected in the county during the 1994-1997 sampling.

Sidenote: A state-endangered glassy darter was collected from lower Morgan Run, and a population of Potomac sculpin was documented in a tributary to Prettyboy Reservoir during sampling in 2000.

Eighteen species of reptiles and amphibians were found in or near Carroll county streams (Table 4), tying the county for a ranking of ninth in the state. No state or federally listed reptiles or amphibians were collected during the sampling in Carroll county. However, bog turtle, a globally threatened species, are known to exist in some wetlands in the county.

Ecological Health

The overall ecological health of Carroll county streams can best be described as Fair. The average F-IBI score among sites was 3.89 (rating of Fair, but nearly in the Good range), and the average B-IBI score was 2.8 (rating of Poor, but near the Fair range). Among basins, the Gunpowder drainage within the county appears to be in the best condition, followed by the Patapsco, Middle Potomac (Monocacy), and Conewago (Susquehanna) drainages. Based on F-IBI and B-IBI scores from the 1994-1997 MBSS, the highest rated streams in the county include Piney Branch, an unnamed tributary to Little Morgan Run, and Piney Run (Table 6). The lowest rated streams include Priestland Branch, Roop Branch, Copp's Branch, an unnamed tributary to Big Pipe Creek, Sam's Creek, and a portion of Bear Branch.

Physical Habitat

Physical habitat in Carroll County was rated as Poor by the Physical Habitat Index. Values ranged from 2.3 to 98.0, with an average score of 62.8 (high end of the Fair range, ranking third among counties in the state) (Table 6; Figure 5). Other noteworthy points about Carroll County streams include relatively low abundances of woody debris and instream rootwads, 1 and 2 per sample segment, respectively. However, instream habitat and epifaunal substrate, each with an average rating of 14, ranked among the top three scores in the state.

Nitrate-Nitrogen

Nitrate-nitrogen values at sites sampled in Carroll county averaged 4.8 mg/L, nearly the worst of any county in the state. The highest values appear to be in the central part of the county, with the northern and southern sections having lower, but still elevated levels. All of the streams sampled had elevated nitrate levels, and the worst streams included: Roop Branch, Priestland Branch, Cranberry Branch, Morgan Run, an unnamed tributary to Beaver Run, an unnamed tributary to Gillis Falls, and Meadow Branch (Table 7). The EPA limit for drinking water (10 mg/L) was exceeded in Roop Branch and Priestland Branch.

Table 1. Site information and land use data collected at Maryland Biological Stream Survey sites in Carroll County, 1994-1997. Basin abbreviations are as follows: CO - Conewago Creek; GU- Gunpowder River; MP - Middle Potomac River; PP - Patapsco River.

Site	Latitude	Longitude	Stream Name	Basin	Order	Catchment Acres	% Urban	% Agric.	% Forest
BA-P-191-211-96	39.6230	76.8260	Murphy Run	GU	2	2045.53	2.37	89.22	8.26
CR-P-000-938-97	39.7194	76.9450	Ut Conewago Cr	CO	1	901.71	0.00	41.94	57.87
CR-P-000-939-97	39.7164	76.9686	Ut Conewago Cr	CO	1	669.83	1.43	84.09	13.67
CR-P-000-940-97	39.7189	76.9842	Ut Conewago Cr	CO	1	457.49	0.07	94.64	4.98
CR-P-003-316-95	39.3767	77.0133	Piney Branch	PP	3	4011.46	1.84	78.47	18.27
CR-P-013-108-96	39.7073	77.0808	Un Trib To Piney Cr	PP	1	104.79	0.00	58.77	41.23
CR-P-019-201-96	39.6355	77.0557	Bear Br	MP	2	3335.39	0.56	78.66	18.96
CR-P-019-248-96	39.6314	77.0339	Bear Br	MP	2	2313.30	0.07	80.77	17.41
CR-P-020-208-96	39.4110	76.9240	Un Trib To Liberty Res	PP	2	1320.14	6.64	67.65	24.75
CR-P-021-329-96	39.5480	77.1699	Sam's Cr	MP	3	10745.17	0.11	77.99	21.06
CR-P-026-109-96	39.4300	77.0770	Un Trib To Gillis Fls	PP	1	819.30	1.70	80.10	17.37
CR-P-035-216-96	39.6803	77.0794	Silver Run	MP	2	4851.84	0.53	74.56	22.09
CR-P-038-227-95	39.5849	76.9761	W Br Patapsco R	PP	2	3818.93	15.58	79.08	4.93
CR-P-047-316-96	39.6960	76.8070	Gunpowder Fls	GU	3	17422.65	0.45	69.37	29.97
CR-P-050-106-95	39.5357	76.9406	Ut Beaver Run	PP	1	331.85	0.00	90.80	9.20
CR-P-070-314-96	39.7130	76.8310	Trib To Little Fls Run	GU	3	10346.75	0.58	69.06	30.17
CR-P-077-309-95	39.5320	76.8871	N Br Patapsco R	PP	3	13672.69	5.33	68.23	26.14
CR-P-079-209-96	39.4660	76.9120	Middle Run	PP	2	3761.71	0.68	83.40	14.84
CR-P-084-309-96	39.4880	77.0130	Morgan Run	PP	3	9758.76	0.65	77.22	20.41
CR-P-086-313-96	39.3700	77.0750	Gillis Fls	PP	3	12157.17	0.77	72.58	23.73
CR-P-086-325-96	39.3730	77.0850	Gillis Fls	PP	3	11700.23	0.80	72.54	23.65
CR-P-094-349-96	39.5577	77.0738	Turkey Foot Run	MP	3	7335.95	8.33	73.27	17.89
CR-P-112-122-95	39.4197	76.9458	Ut Morgan Run	PP	1	99.32	10.69	82.42	6.89
CR-P-115-111-95	39.4124	76.9257	Ut Liberty Reservoir	PP	1	424.08	0.24	62.87	36.73
CR-P-116-316-96	39.6536	77.2272	Piney Cr	MP	3	20934.95	2.55	82.02	13.45
CR-P-116-327-96	39.6542	77.2286	Piney Cr	MP	3	20987.05	2.55	81.97	13.51
CR-P-120-232-96	39.3620	77.0680	Patapsco R	PP	2	7324.04	4.99	67.91	25.20
CR-P-138-116-95	39.3917	77.0657	Ut Gillis Falls	PP	1	273.59	0.00	95.41	4.47
CR-P-142-324-96	39.6926	77.1523	Piney Cr	MP	3	11929.68	1.93	81.76	13.84
CR-P-143-218-95	39.4905	77.0298	Ut Morgan Run	PP	2	2671.35	0.84	76.21	22.01
CR-P-149-118-96	39.5210	76.9010	Roaring Run	PP	1	1124.50	6.51	71.70	21.79
CR-P-152-302-96	39.4970	76.8790	North Br Patapsco R	PP	3	36175.84	3.47	73.45	22.74
CR-P-152-318-95	39.4991	76.8822	N Br Patapsco R	PP	3	32298.53	2.07	72.75	24.85
CR-P-156-314-96	39.7150	77.1116	Piney Cr	MP	3	6947.73	3.19	82.85	12.29
CR-P-156-361-96	39.7161	77.1108	Piney Cr	MP	3	6917.45	3.20	82.83	12.29
CR-P-158-123-96	39.5356	77.1316	Priestland Br	MP	1	95.61	0.00	95.71	4.29
CR-P-162-207-96	39.6159	77.1455	Meadow Br	MP	2	1196.29	1.71	83.97	13.72
CR-P-166-221-95	39.4371	76.9914	Little Morgan Run	PP	2	1754.17	0.19	68.75	30.49
CR-P-171-306-96	39.7100	76.8270	Gunpowder Fls	GU	3	12658.01	0.51	71.12	28.17
CR-P-175-113-95	39.4434	77.0128	Ut Little Morgan Run	PP	1	302.76	0.23	72.48	27.18
CR-P-180-124-96	39.6611	77.1283	Un Trib To Big Pipe Cr	MP	1	709.40	0.14	81.77	17.41
CR-P-193-311-96	39.4920	76.9020	Beaver Run	PP	3	8262.77	4.61	69.41	24.03
CR-P-205-319-96	39.6495	77.1310	Big Pipe	MP	3	35240.18	0.71	73.50	24.00
CR-P-215-127-96	39.4740	76.8970	Un Trib To Liberty Res	PP	1	301.45	0.23	73.30	26.24
CR-P-224-226-95	39.5184	76.9489	Middle Run	PP	2	2075.70	3.51	68.33	26.99
CR-P-227-305-96	39.5160	76.8820	Patapsco R	PP	3	33286.17	3.05	73.99	22.65
CR-P-234-216-96	39.4330	77.0290	Un Trib To Piney Run	PP	2	1569.19	1.85	81.19	15.75
CR-P-240-225-95	39.4973	76.8698	Ut N Br Patapsco R	PP	2	3730.31	0.69	72.55	25.53

Table 1 (cont.). Site information and land use data collected at Maryland Biological Stream Survey sites in Carroll County, 1994-1997. Basin abbreviations are as follows: CO - Conewago Creek; GU - Gunpowder River; MP - Middle Potomac River; PP - Patapsco River.

Site	Latitude	Longitude	Stream Name	Basin	Order	Catchment Acres	% Urban	% Agric.	% Forest
CR-P-242-224-96	39.5500	76.8870	East Br Patapsco	PP	2	13006.75	1.64	78.65	19.53
CR-P-243-333-96	39.6609	77.0014	Big Pipe Cr	MP	3	12953.00	0.82	74.97	23.70
CR-P-249-103-96	39.6013	77.1966	Un Trib To Big Pipe	MP	1	198.36	0.00	88.16	11.84
CR-P-249-113-96	39.5987	77.1978	Un Trib To Big Pipe	MP	1	119.08	0.00	87.43	12.57
CR-P-260-210-96	39.5390	76.9600	Beaver Run	PP	2	1694.06	11.68	72.73	15.59
CR-P-260-212-95	39.5385	76.9594	Beaver Run	PP	2	1721.55	11.86	72.48	15.66
CR-P-263-332-96	39.5671	77.0664	Little Pipe Cr	MP	3	6627.23	9.19	71.92	18.43
CR-P-270-104-95	39.6118	76.9546	Cranberry Branch	PP	1	759.26	0.00	82.21	16.49
CR-P-274-104-96	39.5834	77.1081	Roop Br	MP	1	308.94	0.22	90.52	7.61
CR-P-280-340-96	39.6606	77.0407	Big Pipe Cr	MP	3	22488.27	0.86	73.49	24.77
CR-P-281-127-95	39.3649	77.1248	Ut Patapsco R	PP	1	722.44	7.14	69.17	22.32
CR-P-284-328-96	39.6621	77.0844	Big Pipe	MP	3	25435.44	0.84	74.10	23.83
CR-P-294-124-95	39.5603	76.8498	Aspen Run	PP	1	328.62	2.93	82.93	14.03
CR-P-295-128-96	39.5785	77.0108	Copps Br	MP	1	289.55	18.45	76.62	4.94
CR-P-318-338-96	39.6341	77.1311	Bear Br	MP	3	8976.59	0.48	79.27	17.76
CR-P-323-326-96	39.6530	77.1274	Big Pipe	MP	3	34151.41	0.73	73.20	24.25
CR-P-330-201-96	39.5810	76.8920	East Br Patapsco	PP	2	6807.21	2.79	83.18	13.72
CR-P-330-229-96	39.5890	76.8860	East Br Patapsco	PP	2	6319.31	3.00	84.00	12.68
CR-P-341-121-96	39.4200	76.9670	Un Trib To Little Morgan Run	PP	1	913.55	5.25	77.05	17.70
CR-P-344-219-96	39.6140	76.8840	East Br Of Patapsco	PP	2	2351.41	0.45	81.88	16.94
CR-P-345-321-96	39.4530	76.9570	Morgan Run	PP	3	17772.86	0.71	68.97	28.83
CR-P-362-302-95	39.3618	76.9059	Piney Run	PP	3	11404.81	3.87	69.99	24.49
CR-P-362-304-95	39.3613	76.9052	Piney Run	PP	3	11406.85	3.87	69.99	24.49
CR-P-362-310-96	39.3530	76.8970	North Br Patapsco R	PP	3	11808.42	3.76	67.71	26.92
CR-P-362-317-95	39.3756	76.9344	Piney Run	PP	3	9778.63	4.20	73.87	20.61
CR-P-363-212-96	39.3790	76.9530	Piney Run	PP	2	7808.20	3.48	73.48	21.37
CR-P-363-230-96	39.3840	76.9690	Piney Run	PP	2	7097.44	1.69	74.39	22.08
CR-P-365-219-96	39.5993	77.0854	Meadow Br	MP	2	4801.83	1.32	78.45	17.96
CR-P-374-343-96	39.6363	77.0903	Bear Br	MP	3	7103.90	0.38	79.76	17.01
CR-P-376-104-96	39.3940	76.9550	Un Trib To Piney Run	PP	1	504.92	8.77	78.89	12.34
CR-P-376-119-96	39.3950	76.9560	Un Trib To Piney Run	PP	1	453.88	9.23	80.57	10.20
CR-P-379-123-96	39.5310	77.0350	Morgan Run	PP	1	142.22	0.00	89.47	8.85
CR-P-398-222-95	39.4151	77.0729	Gillis Falls	PP	2	3818.98	0.98	75.41	20.82
CR-P-400-144-96	39.6424	77.1509	Un Trib To Big Pipe Cr	MP	1	113.64	5.41	86.19	8.41
CR-P-402-121-95	39.5647	76.8691	Deep Run	PP	1	1962.25	2.87	87.66	9.44
CR-P-403-112-96	39.6720	76.8650	Un Trib To Graves Run	GU	1	199.04	0.00	82.56	17.44
CR-P-406-102-96	39.6697	77.1622	Un Trib To Piney Cr	MP	1	422.92	0.00	90.34	9.66
CR-P-409-320-96	39.5260	76.8770	North Br Patapsco R	PP	3	31722.08	3.20	74.21	22.38
CR-P-415-103-96	39.4210	77.0110	Un Trib To Piney Run	PP	1	117.72	0.00	86.13	9.83
CR-P-419-214-95	39.3947	77.0776	Gillis Falls	PP	2	6423.15	0.94	72.87	23.70
CR-P-419-227-96	39.3990	77.0770	Gillis Fls	PP	2	6173.00	0.96	73.20	23.40
CR-P-434-138-96	39.4969	77.1052	Un Trib To Sam's Cr	MP	1	156.17	0.00	79.74	20.26
CR-P-999-323-95	39.5153	76.9327	Beaver Run	PP	3	6105.85	4.79	71.69	22.19
CR-P-999-323-96	39.5060	76.9290	Beaver Run	PP	3	6433.97	4.54	71.15	22.95
FR-P-474-302-96	39.5651	77.1860	Sam's Cr	MP	3	14058.44	0.43	79.08	19.03
HO-P-036-314-95	39.3604	77.0510	Patapsco R	PP	3	20996.24	2.27	70.97	24.30
HO-P-108-313-95	39.3552	77.0349	Patapsco R	PP	3	22809.88	2.20	71.50	23.86
HO-P-151-222-96	39.3670	77.0850	Patapsco R	PP	2	4706.56	7.04	62.08	28.98

Table 1 (cont.). Site information and land use data collected at Maryland Biological Stream Survey sites in Carroll County, 1994-1997. Basin abbreviations are as follows: CO - Conewago Creek; GU - Gunpowder River; MP - Middle Potomac River; PP - Patapsco River.

Site	Latitude	Longitude	Stream Name	Basin	Order	Catchment Acres	% Urban	% Agric.	% Forest
HO-P-244-307-96	39.3550	77.0360	Patapsco R	PP	3	22375.31	2.19	71.84	23.59
HO-P-244-310-95	39.3581	77.0430	Patapsco R	PP	3	22224.70	2.18	71.75	23.70

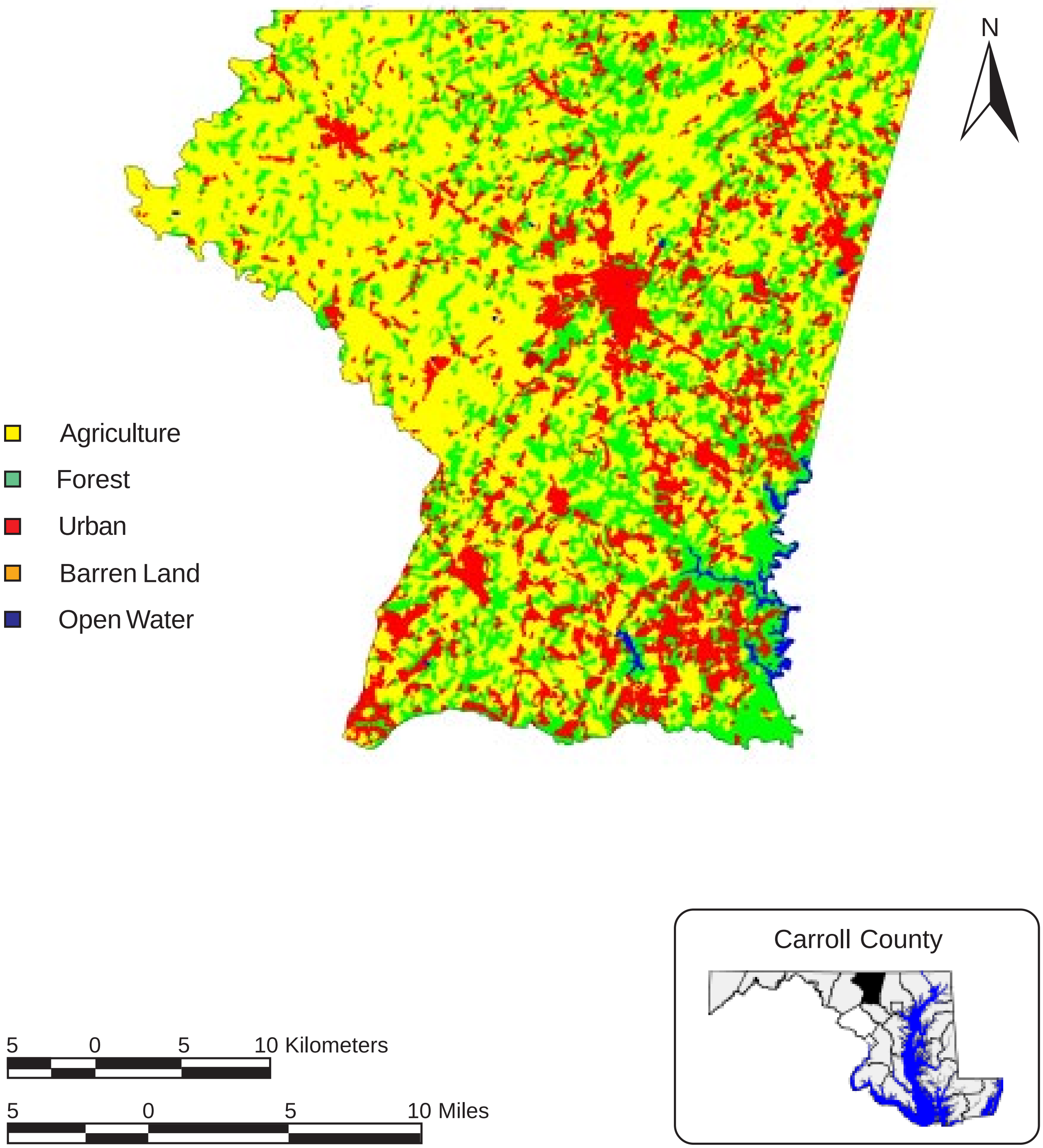

Figure 1. Land use in Carroll County (MOP 1994).

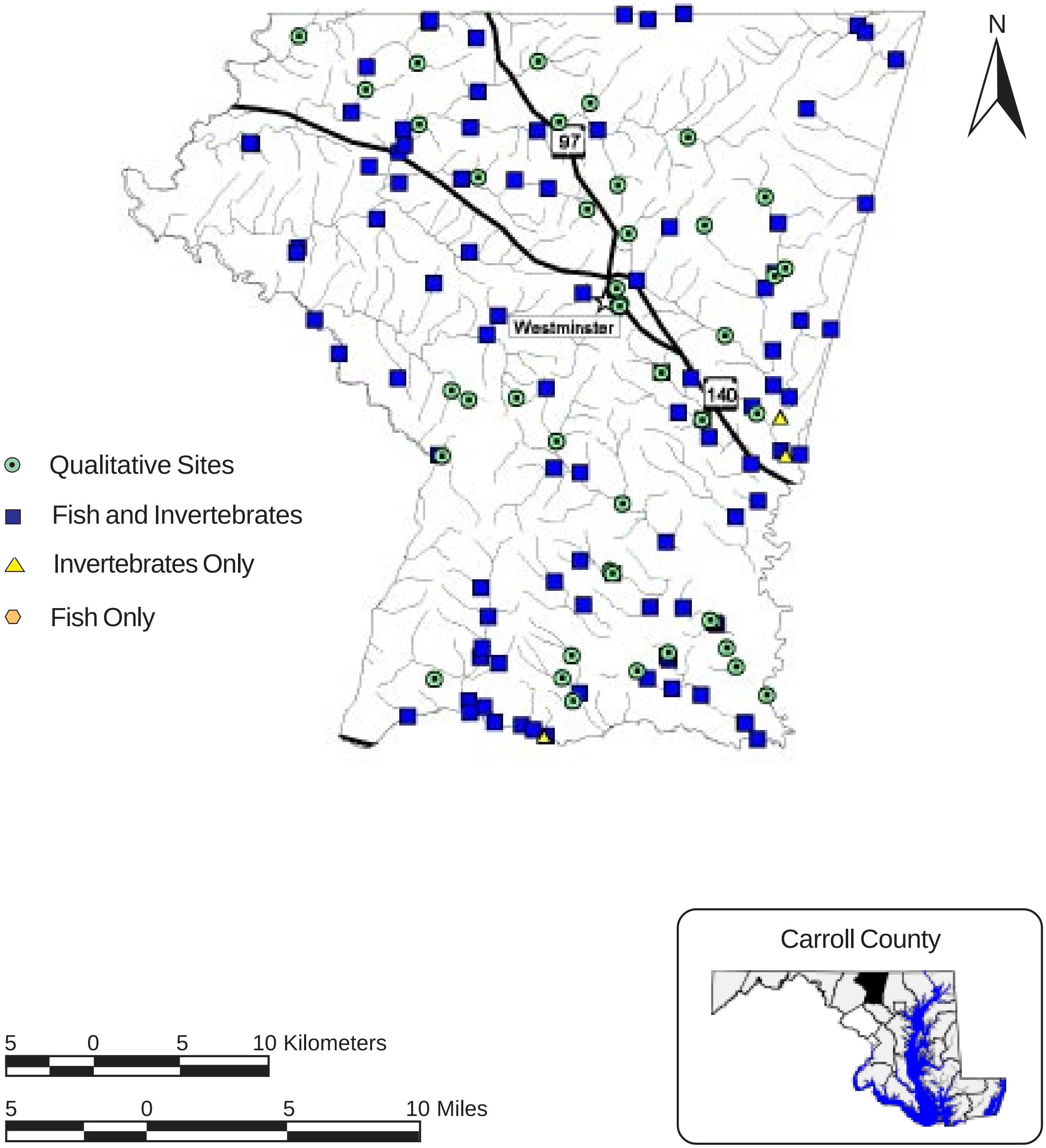

Figure 2. Location of Maryland Biological Stream Survey sites in Carroll County, 1994-1997.

Table 2. Percent occurrence of fish species collected at Maryland Biological Stream Survey sites in Carroll County, 1994-1997.

Family	Common Name	Scientific Name	Number of Occurrences	Percent Occurrence
Anguillidae	American eel	*Anguilla rostrata*	4	4.21
Cyprinidae	central stoneroller	*Campostoma anomalum*	59	62.11
	rosyside dace	*Clinostomus funduloides*	64	67.37
	satinfin shiner	*Cyprinella analostana*	12	12.63
	spotfin shiner	*Cyprinella spiloptera*	5	5.26
	common carp	*Cyprinus carpio*	4	4.21
	cutlips minnow	*Exoglossum maxillingua*	41	43.16
	eastern silvery minnow	*Hybognathus regius*	4	4.21
	common shiner	*Luxilus cornutus*	40	42.11
	river chub	*Nocomis micropogon*	22	23.16
	golden shiner	*Notemigonus crysoleucas*	3	3.16
	comely shiner	*Notropis amoenus*	2	2.11
	silverjaw minnow	*Notropis buccatus*	8	8.42
	spottail shiner	*Notropis hudsonius*	16	16.84
	swallowtail shiner	*Notropis procne*	6	6.32
	rosyface shiner	*Notropis rubellus*	11	11.58
	bluntnose minnow	*Pimephales notatus*	48	50.53
	fathead minnow	*Pimephales promelas*	1	1.05
	blacknose dace	*Rhinichthys atratulus*	85	89.47
	longnose dace	*Rhinichthys cataractae*	69	72.63
	creek chub	*Semotilus atromaculatus*	79	83.16
	fallfish	*Semotilus corporalis*	4	4.21
Catostomidae	white sucker	*Catostomus commersoni*	77	81.05
	northern hogsucker	*Hypentelium nigricans*	41	43.16
Ictaluridae	yellow bullhead	*Ameiurus natalis*	19	20.00
	brown bullhead	*Ameiurus nebulosus*	4	4.21
	channel catfish	*Ictalurus punctatus*	1	1.05
	margined madtom	*Noturus insignis*	18	18.95
Salmonidae	cutthroat trout	*Oncorhynchus clarki*	1	1.05
	rainbow trout	*Oncorhynchus mykiss*	2	2.11
	brown trout	*Salmo trutta*	20	21.05
	brook trout	*Salvelinus fontinalis*	1	1.05
Cottidae	mottled sculpin	*Cottus bairdi*	70	73.68
	Potomac sculpin	*Cottus girardi*	18	18.95
Centrarchidae	rock bass	*Ambloplites rupestris*	7	7.37
	redbreast sunfish	*Lepomis auritus*	22	23.16
	green sunfish	*Lepomis cyanellus*	20	21.05
	pumpkinseed	*Lepomis gibbosus*	16	16.84
	bluegill	*Lepomis machrochirus*	42	44.21
	smallmouth bass	*Micropterus dolomieu*	14	14.74
	largemouth bass	*Micropterus salmoides*	37	38.95
Percidae	greenside darter	*Etheostoma blennioides*	17	17.89
	fantail darter	*Etheostoma flabellare*	21	22.11
	tessellated darter	*Etheostoma olmstedi*	45	47.37
None			5	5.26

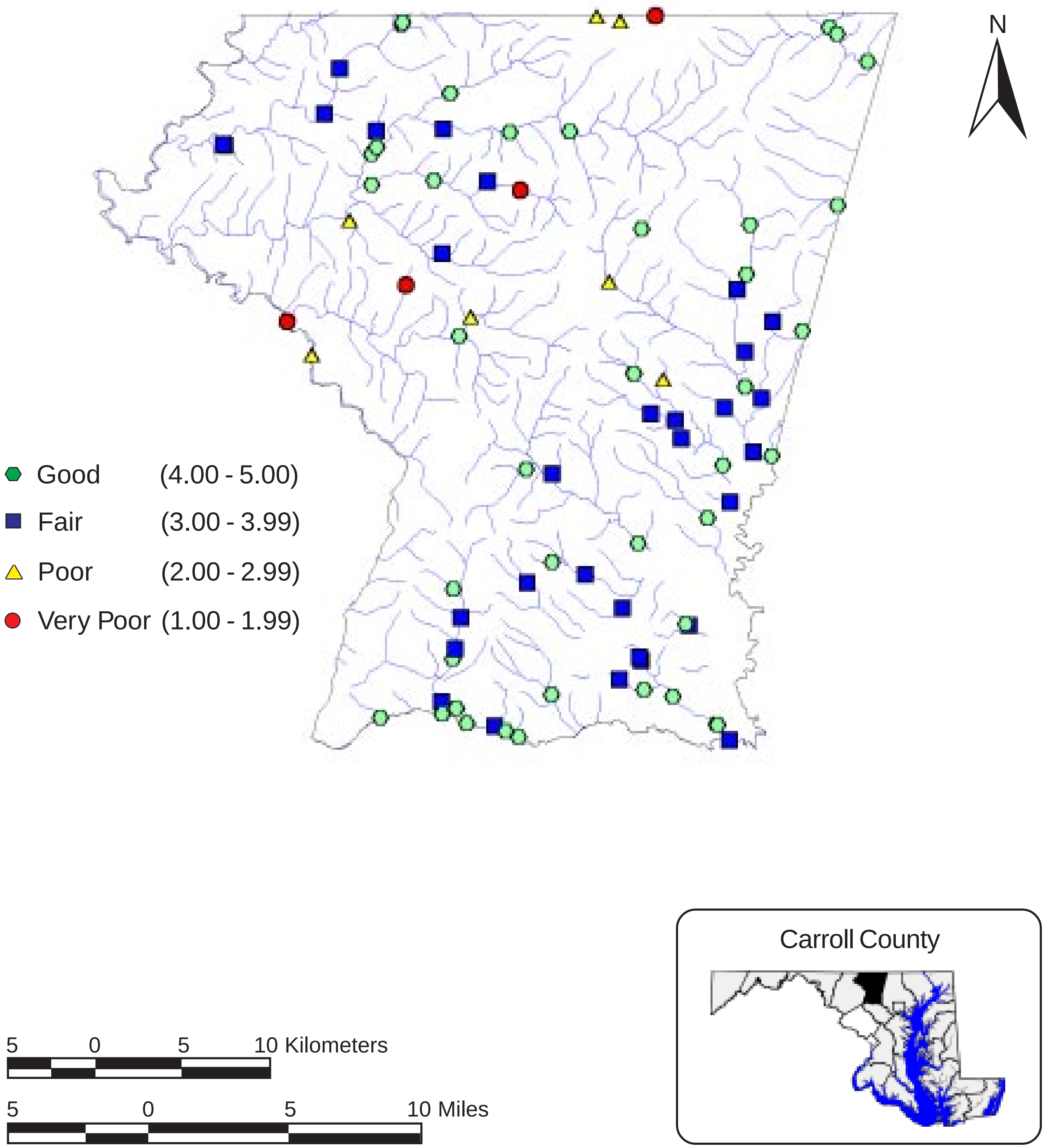

Figure 3. Stream ecological conditions based on the Fish Index of Biotic Integrity (F-IBI) at Maryland Biological Stream Survey sites in Carroll County, 1994-1997.

Table 3. Tolerance Value (TV)[1], Functional Feeding Group (FFG), Habit, and Percent Occurrence of benthic macroinvertebrate taxa[2] collected at Maryland Biological Stream Survey sites in Carroll County, 1994-1997. Abbreviations of habits are as follows: bu - burrower, cn - clinger, cb - climber, sp - sprawler, dv - diver, and sk - skater.

Class	Order	Family	Genus	TV	FFG	Habit	Percent Occurrence
Nematomorpha[3]					Predator	bu	1.02
Enopla	Hoplonemertea	Tetrastemmatidae	*Prostoma* Sp.		Predator		1.02
Turbellaria				4	Predator	sp	1.02
	Tricladida	Planariidae	*Cura* Sp.			sp	1.02
Oligochaeta				10	Collector	bu	1.02
Oligochaeta	Lumbriculida	Lumbriculidae		10	Collector	bu	5.10
Oligochaeta	Tubificida	Enchytraeidae		10	Collector	bu	3.06
		Naididae		10	Collector	bu	12.24
		Tubificidae		10	Collector	cn	9.18
			Limnodrilus Sp.	10	Collector	cn	2.04
Hirudinea				8	Predator	sp	3.06
Hirudinea	Rhynchobdellida	Piscicolidae	*Piscicola* Sp.		Predator	sp	1.02
Gastropoda	Basommatophora	Ancylidae			Scraper	cb	1.02
			Fissia Sp.	7	Scraper	cb	1.02
		Lymnaeidae		6	Scraper	cb	1.02
			Fossaria Sp.	8	Scraper	cb	1.02
		Physidae		8	Scraper	cb	1.02
			Physella Sp.	8	Scraper	cb	5.10
		Planorbidae		7	Scraper	cb	1.02
			Gyraulus Sp.	8	Scraper	cb	1.02
Gastropoda	Mesogastropoda	Pleuroceridae	*Leptoxis* Sp.		Scraper	cb	2.04
Pelecypoda	Veneroida	Corbiculidae	*Corbicula* Sp.	6	Filterer	bu	2.04
		Sphaeriidae	*Pisidium* Sp.	8	Filterer	bu	1.02
			Sphaerium Sp.	8	Filterer	bu	3.06
Malacostraca	Amphipoda	Crangonyctidae	*Crangonyx* Sp.	4	Collector	sp	5.10
		Gammaridae	*Gammarus* Sp.	6	Shredder	sp	1.02
			Stygonectes Sp.	6	Shredder	sp	6.12
		Hyalellidae	*Hyalella* Sp.	6	Shredder	sp	4.08
Malacostraca	Isopoda	Asellidae	*Caecidotea* Sp.	8	Collector	sp	1.02
Insecta	Collembola						2.04
Insecta	Ephemeroptera	Ameletidae	*Ameletus* Sp.	0	Collector	sw, cb	9.18
		Baetidae			Collector	sw, cn	14.29
			Acentrella Sp.	4	Collector	sw, cn	2.04
			Acerpenna Sp.	4	Collector	sw, cn	12.24
			Baetis Sp.	6	Collector	sw, cb, cn	3.06
			Centroptilum Sp.	2	Collector	sw, cn	2.04
			Diphetor Sp.		Collector	sw, cn	5.10
		Caenidae	*Caenis* Sp.	7	Collector	sp	2.04
		Ephemerellidae				cn, sp, sw	2.04
			Drunella Sp.	1	Scraper	cn, sp	1.02
			Ephemerella Sp.	2	Collector	cn, sw	61.22
			Eurylophella Sp.	4	Scraper	cn, sp	26.53
			Satella Sp.	2	Collector	cn	5.10
		Ephemeridae	*Ephemera* Sp.	3	Collector	bu	16.33
		Heptageniidae			Scraper	cn	1.02
			Epeorus Sp.	0	Scraper	cn	8.16
			Leucrocuta Sp.	1	Scraper	cn	4.08

Table 3 (cont.). Tolerance Value (TV)[1], Functional Feeding Group (FFG), Habit, and Percent Occurrence of benthic macroinvertebrate taxa[2] collected at Maryland Biological Stream Survey sites in Carroll County, 1994-1997. Abbreviations of habits are as follows: bu - burrower, cn - clinger, cb - climber, sp - sprawler, dv - diver, and sk - skater.

Class	Order	Family	Genus	TV	FFG	Habit	Percent Occurrence
			Stenacron Sp.	4	Collector	cn	5.10
			Stenonema Sp.	4	Scraper	cn	59.18
		Isonychiidae	*Isonychia* Sp.	2	Filterer	sw, cn	29.59
		Leptophlebiidae			Collector	sw, cn	1.02
			Leptophlebia Sp.	4	Collector	sw, cn, sp	3.06
			Paraleptophlebia Sp.	2	Collector	sw, cn, sp	25.51
Insecta	Odonata	Aeshnidae			Predator	cb	1.02
			Boyeria Sp.	2	Predator	cb, sp	1.02
		Gomphidae			Predator	bu	2.04
			Gomphus Sp.	5	Predator	bu	1.02
			Lanthus Sp.	6	Predator	bu	1.02
			Stylogomphus Sp.		Predator	bu	4.08
Insecta	Plecoptera	Capniidae			Shredder	sp, cn	5.10
			Allocapnia Sp.	3	Shredder	cn	9.18
			Capnia Sp.	1	Shredder	sp, cn	1.02
			Paracapnia Sp.	1	Shredder	-	9.18
		Chloroperlidae			Predator	cn	4.08
			Sweltsa Sp.		Predator	cn	2.04
		Leuctridae	*Leuctra* Sp.	0	Shredder	cn	2.04
		Nemouridae			Shredder	sp, cn	8.16
			Amphinemura Sp.	3	Shredder	sp, cn	33.67
			Ostrocerca Sp.		Shredder	sp, cn	1.02
			Prostoia Sp.		Shredder	sp, cn	33.67
		Peltoperlidae	*Tallaperla* Sp.		Shredder	cn, sp	1.02
		Perlidae			Predator	cn	5.10
			Acroneuria Sp.	0	Predator	cn	5.10
			Eccoptura Sp.		Predator	cn	2.04
		Perlodidae			Predator	cn	4.08
			Clioperla Sp.	1	Predator	cn	4.08
			Cultus Sp.		Predator	cn	1.02
			Isoperla Sp.	2	Predator	cn, sp	5.10
		Pteronarcyidae	*Pteronarcys* Sp.	2	Shredder	cn, sp	1.02
		Taeniopterygidae	*Oemopteryx* Sp.		Shredder	sp, cn	4.08
			Strophopteryx Sp.		Shredder	sp, cn	9.18
			Taeniopteryx Sp.	2	Shredder	sp, cn	2.04
Insecta	Megaloptera	Corydalidae	*Corydalus* Sp.	5	Predator	cn, cb	4.08
			Nigronia Sp.	0	Predator	cn, cb	9.18
		Sialidae	*Sialis* Sp.	4	Predator	bu, cb, cn	3.06
Insecta	Trichoptera	Glossosomatidae	*Glossosoma* Sp.	0	Scraper	cn	5.10
		Hydropsychidae			Filterer	cn	2.04
			Cheumatopsyche Sp.	5	Filterer	cn	62.24
			Diplectrona Sp.	2	Filterer	cn	17.35
			Hydropsyche Sp.	6	Filterer	cn	58.16
		Hydroptilidae	*Hydroptila* Sp.	6	Scraper	cn	1.02
			Leucotrichia Sp.		Scraper	cn	2.04
		Lepidostomatidae	*Lepidostoma* Sp.	3	Shredder	cb, sp, cn	1.02
		Leptoceridae	*Ceraclea* Sp.	3	Collector	sp, cb	1.02

Table 3 (cont.). Tolerance Value (TV)[1], Functional Feeding Group (FFG), Habit, and Percent Occurrence of benthic macroinvertebrate taxa[2] collected at Maryland Biological Stream Survey sites in Carroll County, 1994-1997. Abbreviations of habits are as follows: bu - burrower, cn - clinger, cb - climber, sp - sprawler, dv - diver, and sk - skater.

Class	Order	Family	Genus	TV	FFG	Habit	Percent Occurrence
		Limnephilidae	*Goera* Sp.		Scraper	cn	1.02
			Ironoquia Sp.	3	Shredder	sp	2.04
			Pycnopsyche Sp.	4	Shredder	sp, cb, cn	3.06
		Odontoceridae	*Psilotreta* Sp.	0	Scraper	sp	1.02
		Philopotamidae	*Chimarra* Sp.	4	Filterer	cn	28.57
			Dolophilodes Sp.	0	Filterer	cn	3.06
		Phryganeidae	*Ptilostomis* Sp.	5	Shredder	cb	1.02
		Polycentropodidae				cn	1.02
			Polycentropus Sp.	5	Filterer	cn	2.04
		Psychomyiidae	*Psychomyia* Sp.	2	Collector	cn	2.04
		Rhyacophilidae	*Rhyacophila* Sp.	1	Predator	cn	13.27
		Uenoidae	*Neophylax* Sp.	3	Scraper	cn	29.59
Insecta	Lepidoptera	Pyralidae			Shredder	cb	1.02
Insecta	Coleoptera	Curculionidae					1.02
		Dryopidae	*Helichus* Sp.	5	Scraper	cn	2.04
		Dytiscidae	*Agabus* Sp.	5	Predator	sw, dv	2.04
			Hydroporus Sp.	5	Predator	sw, cb	1.02
		Elmidae		5	Collector	cn	1.02
			Ancyronyx Sp.	2	Scraper	cn, sp	1.02
			Dubiraphia Sp.	6	Scraper	cn, cb	5.10
			Macronychus Sp.	4	Scraper	cn	3.06
			Optioservus Sp.	4	Scraper	cn	56.12
			Oulimnius Sp.	2	Scraper	cn	11.22
			Stenelmis Sp.	6	Scraper	cn	29.59
		Gyrinidae	*Dineutus* Sp.	4	Predator	sw, dv	2.04
		Haliplidae	*Haliplus* Sp.	5	Shredder	cb	1.02
		Hydrophilidae	*Hydrobius* Sp.	5	Collector	cb, cn, sp	1.02
			Hydrophilus Sp.	5	Collector	sw, dv, cb	1.02
		Psephenidae	*Ectopria* Sp.	5	Scraper	cn	1.02
			Psephenus Sp.	4	Scraper	cn	6.12
		Ptilodactylidae	*Anchytarsus* Sp.	4	Shredder	cn	8.16
Insecta	Diptera	Ceratopogonidae			Predator	sp, bu	1.02
			Bezzia Sp.	6	Predator	bu	7.14
			Helius Sp.	4	Predator	sp, bu	1.02
			Probezzia Sp.	6	Predator	bu	1.02
		Chironomidae					2.04
			Brillia Sp.	5	Shredder	bu, sp	10.20
			Cardiocladius Sp.	6	Predator	bu, cn	1.02
			Chironomus Sp.	10	Collector	bu	3.06
			Conchapelopia Sp.	6	Predator	sp	36.73
			Corynoneura Sp.	7	Collector	sp	7.14
			Cricotopus Sp.	7	Shredder	cn, bu	13.27
			Cricotopus/ Orthocladius Sp.		Shredder		52.04
			Cryptochironomus Sp.	8	Predator	sp, bu	1.02
			Diamesa Sp.	5	Collector	sp	26.53
			Diplocladius Sp.	7	Collector	sp	2.04

Table 3 (cont.). Tolerance Value (TV)[1], Functional Feeding Group (FFG), Habit, and Percent Occurrence of benthic macroinvertebrate taxa[2] collected at Maryland Biological Stream Survey sites in Carroll County, 1994-1997. Abbreviations of habits are as follows: bu - burrower, cn - clinger, cb - climber, sp - sprawler, dv - diver, and sk - skater.

Class	Order	Family	Genus	TV	FFG	Habit	Percent Occurrence
			Endochironomus Sp.	10	Shredder	cn	1.02
			Eukiefferiella Sp.	8	Collector	sp	17.35
			Heterotrissocladius Sp.		Collector	sp, bu	1.02
			Hydrobaenus Sp.	8	Scraper	sp	10.20
			Krenopelopia Sp.		Predator	sp	3.06
			Larsia Sp.	6	Predator	sp	4.08
			Micropsectra Sp.	7	Collector	cb, sp	5.10
			Microtendipes Sp.	6	Filterer	cn	16.33
			Nanocladius Sp.	3	Collector	sp	4.08
			Orthocladiinae A Sp.		Collector		5.10
			Orthocladius Sp.	6	Collector	sp, bu	37.76
			Paracladopelma Sp.	7	Collector	sp	2.04
			Parakiefferiella Sp.	4	Collector	sp	4.08
			Paramerina Sp.	4	Predator	sp	4.08
			Parametriocnemus Sp.	5	Collector	sp	64.29
			Paratanytarsus Sp.	6	Collector	sp	3.06
			Paratrichocladius Sp.		Collector	sp	1.02
			Phaenopsectra Sp.	7	Collector	cn	1.02
			Polypedilum Sp.	6	Shredder	cb, cn	24.49
			Potthastia Sp.	2	Collector	sp	1.02
			Procladius Sp.	9	Predator	sp	1.02
			Psilometriocnemus Sp.		Collector	sp	1.02
			Rheocricotopus Sp.	6	Collector	sp	4.08
			Rheotanytarsus Sp.	6	Filterer	cn	10.20
			Stempellinella Sp.	4	Collector	cb, sp, cn	2.04
			Stictochironomus Sp.	9	Collector	bu	8.16
			Sublettea Sp.		Collector	-	3.06
			Sympotthastia Sp.	2	Collector	sp	20.41
			Tanytarsus Sp.	6	Filterer	cb, cn	25.51
			Thienemanniella Sp.	6	Collector	sp	11.22
			Thienemannimyia Sp.		Predator	sp	10.20
			Tribelos Sp.	5	Collector	bu	3.06
			Trissopelopia Sp.		Predator	sp	7.14
			Tvetenia Sp.	5	Collector	sp	5.10
			CHIRONOMINAE	6	Collector		1.02
			DIAMESINAE		Collector		1.02
			ORTHOCLADIINAE		Collector		14.29
			TANYPODINAE		Predator		2.04
			TANYTARSINI		Collector		3.06
			Zavrelimyia Sp.	8	Predator	sp	9.18
		Dixidae	*Dixa* Sp.	4	Predator	sw, cb	2.04
		Empididae			Predator	sp, bu	2.04
			Chelifera Sp.		Predator	sp, bu	13.27
			Clinocera Sp.		Predator	cn	20.41
			Hemerodromia Sp.	6	Predator	sp, bu	24.49
		Simuliidae		7	Filterer	cn	3.06
			Prosimulium Sp.	7	Filterer	cn	59.18

Table 3 (cont.). Tolerance Value (TV)[1], Functional Feeding Group (FFG), Habit, and Percent Occurrence of benthic macroinvertebrate taxa[2] collected at Maryland Biological Stream Survey sites in Carroll County, 1994-1997. Abbreviations of habits are as follows: bu - burrower, cn - clinger, cb - climber, sp - sprawler, dv - diver, and sk - skater.

Class	Order	Family	Genus	TV	FFG	Habit	Percent Occurrence
			Simulium Sp.	7	Filterer	cn	21.43
			Stegopterna Sp.	7	Filterer	cn	19.39
		Tabanidae	*Chrysops* Sp.	7	Predator	sp, bu	3.06
		Tipulidae			Predator	bu, sp	1.02
			Antocha Sp.	5	Collector	cn	44.90
			Cryptolabis Sp.			bu	2.04
			Dicranota Sp.	4	Predator	sp, bu	12.24
			Erioptera Sp.	7	Collector	bu	1.02
			Hexatoma Sp.	4	Predator	bu, sp	13.27
			Pseudolimnophila Sp.	2	Predator	bu	9.18
			Tipula Sp.	4	Shredder	bu	23.47

[1] Tolerance values are on a 0 (extremely sensitive) to 10 (tolerant) scale.
[2] Taxa not identified to genus are presented in capital letters. Subfamily - Tanypodinae, Orthocladiinae, Diamesinae, Chironominae; Tribe - Tanytarsini.
[3] Nematomorpha is a phylum level identification. No further identification was made.

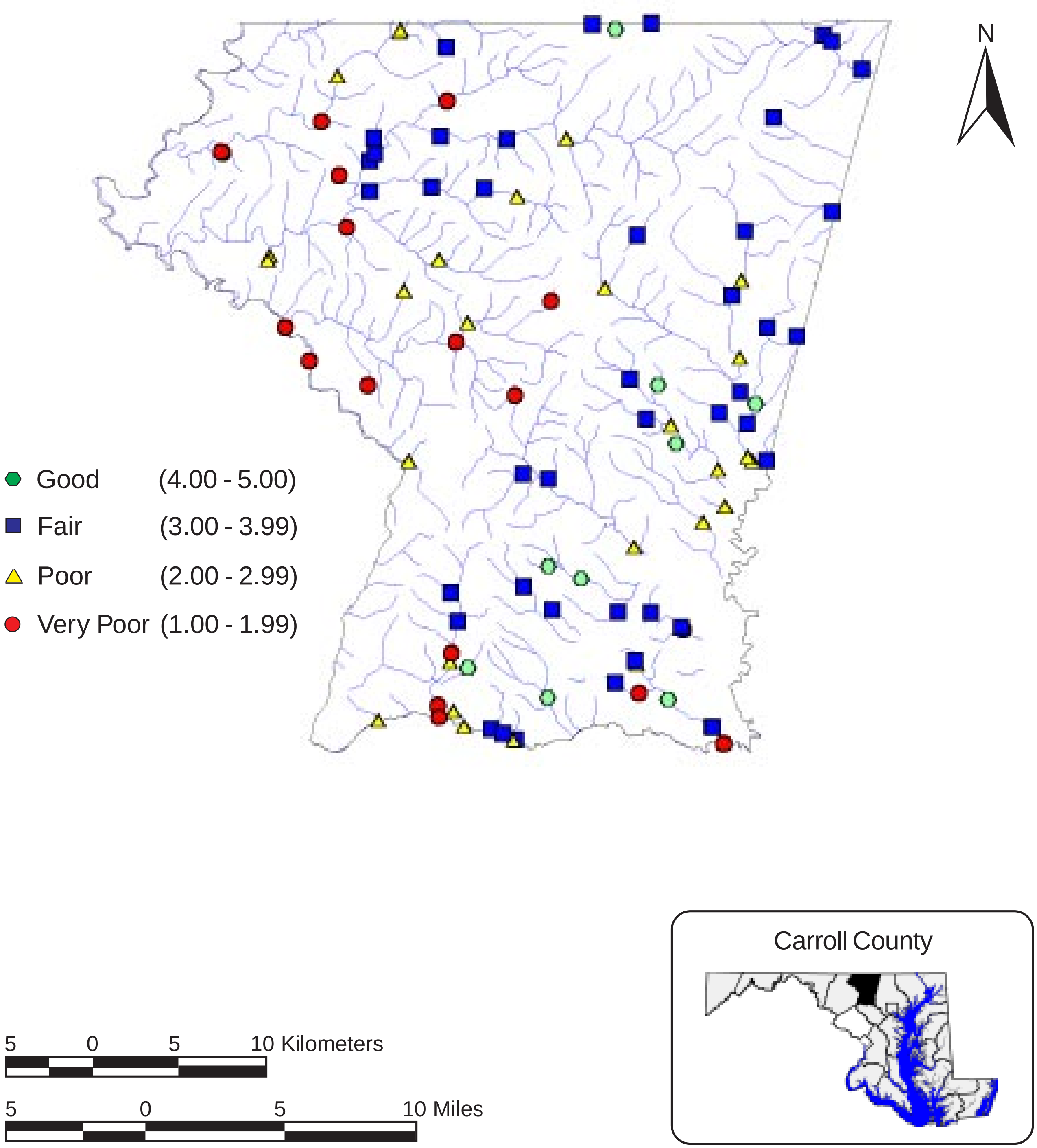

Figure 4. Stream ecological conditions based on the Benthic Macroinvertebrate Index of Biotic Integrity (B-IBI) at Maryland Biological Stream Survey sites in Carroll County, 1994-1997.

Table 4. Percent occurrence of reptile and amphibian species collected at Maryland Biological Stream Survey sites in Carroll County, 1994-1997.

Family	Common Name	Scientific Name	Number of Occurrences	Percent Occurrence
Plethodontidae	longtail salamander	*Eurycea l. longicauda*	4	4.21
	northern dusky salamander	*Desmognathus f. fuscus*	8	8.42
	northern two-lined salamander	*Eurycea bislineata*	40	42.11
	northern spring salamander	*Gyrinophilus p. porphyriticus*	2	2.11
	red salamander	*Pseudotriton ruber*	10	10.53
	redback salamander	*Plethodon cinereus*	13	13.68
Bufonidae	American toad	*Bufo americanus*	20	21.05
	Fowler's toad	*Bufo woodhousii fowleri*	3	3.16
Hylidae	northern spring peeper	*Pseudacris c. crucifer*	2	2.11
Ranidae	bullfrog	*Rana catesbeiana*	16	16.84
	green frog	*Rana clamitans melanota*	19	20.00
	pickerel frog	*Rana palaustris*	28	29.47
	wood frog	*Rana sylvatica*	4	4.21
Chelydridae	common snapping turtle	*Chelydra serpentina*	14	14.74
Emydidae	eastern box turtle	*Terrapene c. carolina*	4	4.21
Colubridae	eastern garter snake	*Thamnophis s. sirtalis*	1	1.05
	northern ringneck snake	*Diadophis punctatus edwardsii*	2	2.11
	northern water snake	*Nerodia s. sipedon*	12	12.63
None			8	8.42

Table 5. Physical habitat data for Maryland Biological Stream Survey sites in Carroll County, 1994-1997.

Site	Instream Habitat[1]	Epifaunal Substrate[1]	Velocity/Depth Diversity[1]	Pool Quality[1]	Riffle Quality[1]	Percent Embeddedness[1]	Percent Shading[1]	Maximum Depth (cm)[1]	Number of Woody Debris	Number of Rootwads	Percent Channel Flow[1]	Channel Alteration[1]	Bank Stability[1]	Riparian Width (m)[1]	Aesthetic Rating[1]
BA-P-191-211-96	16	14	16	15	16	70	85	63	0	1	90	15	9	30	13
CR-P-000-938-97	12	11	6	10	8	40	95	17	2	1	90	14	18	35	16
CR-P-000-939-97	17	19	8	13	14	20	85	30	1	0	97	16	15	1	13
CR-P-000-940-97	14	13	13	17	14	40	96	65	1	1	90	15	7	0	13
CR-P-003-316-95	12	17	11	11	13	25	85	52	5	1	95	10	9	50	14
CR-P-013-108-96	15	16	10	11	11	20	85	34	3	0	80	13	13	32	6
CR-P-019-201-96	12	11	16	16	14	50	85	83	3	5	95	8	9	50	16
CR-P-019-248-96	11	10	16	14	12	65	70	66	5	2	85	10	8	0	16
CR-P-020-208-96	17	12	14	16	13	60	80	54	1	2	85	10	9	0	10
CR-P-021-329-96	14	17	10	18	7	17	90	66	2	3	100	5	15	0	19
CR-P-026-109-96	14	14	11	13	15	30	80	52	5	3	95	17	15	0	15
CR-P-035-216-96	14	14	15	15	15	50	78	108	3	6	92	11	13	15	17
CR-P-038-227-95	10	12	16	11	14	15	90	74	1	3	80	8	10	10	6
CR-P-047-316-96	17	19	15	15	20	25	30	46	2	3	95	17	15	0	15
CR-P-050-106-95	14	17	8	8	10	10	90	46	1	2	90	8	8	40	17
CR-P-070-314-96	13	7	13	11	16	60	65	52	1	3	80	8	7	50	6
CR-P-077-309-95	18	15	17	18	17	10	60	111	0	0	100	16	8	0	11
CR-P-079-209-96	16	16	15	15	16	20	90	120	1	4	90	12	7	0	12
CR-P-084-309-96	16	17	20	19	16	30	75	130	4	1	82	7	6	50	12
CR-P-086-313-96	16	16	17	16	18	20	70	82	9	2	95	17	15	50	18
CR-P-086-325-96	15	16	17	13	18	10	45	110	1	0	90	8	3	0	17
CR-P-094-349-96	16	17	16	13	17	20	73	77	1	3	93	12	10	0	14
CR-P-112-122-95	14	14	8	8	10	10	95	39	4	2	65	8	5	15	6
CR-P-115-111-95	16	17	13	14	12	20	85	62	5	4	95	16	8	6	18
CR-P-116-316-96	18	11	16	18	11	55	75	100	2	1	85	10	7	4	16
CR-P-116-327-96	15	16	17	17	14	40	85	60	1	2	85	12	7	0	12
CR-P-120-232-96	16	18	18	16	18	10	50	100	1	2	75	11	4	0	14
CR-P-138-116-95	13	16	7	6	10	15	65	23	2	0	70	8	5	0	11
CR-P-142-324-96	12	7	15	17	10	85	60	63	2	1	95	5	6	0	9
CR-P-143-218-95	9	11	9	8	14	50	20	29	1	0	96	16	9	0	16
CR-P-149-118-96	19	19	11	14	16	15	90	57	2	1	85	12	2	50	15
CR-P-152-318-95	14	15	11	16	18	50	40	50	2	0	95	11	7	0	10
CR-P-156-314-96	15	11	13	17	13	18	85	100	0	2	95	16	8	0	15
CR-P-156-361-96	16	15	13	17	14	17	80	90	2	5	98	17	9	0	14
CR-P-158-123-96	8	11	6	6	10	75	75	17	0	0	90	3	6	0	10
CR-P-162-207-96	16	14	16	13	15	25	80	69	1	0	80	9	11	0	14

Table 5 (cont.). Physical habitat data for Maryland Biological Stream Survey sites in Carroll County, 1994-1997.

Site	Instream Habitat[1]	Epifaunal Substrate[1]	Velocity/Depth Diversity[1]	Pool Quality[1]	Riffle Quality[1]	Percent Embeddedness[1]	Percent Shading[1]	Maximum Depth (cm)[1]	Number of Woody Debris	Number of Rootwads	Percent Channel Flow[1]	Channel Alteration[1]	Bank Stability[1]	Riparian Width (m)[1]	Aesthetic Rating[1]
CR-P-166-221-95	17	18	10	11	18	13	65	38	0	0	92	16	12	10	17
CR-P-171-306-96	14	13	16	13	16	65	80	65	2	2	100	11	15	0	13
CR-P-175-113-95	15	17	8	10	15	5	95	41	1	0	85	11	8	50	18
CR-P-180-124-96	9	10	11	11	11	35	85	51	1	2	90	8	7	50	16
CR-P-193-311-96	17	16	18	17	17	35	30	92	1	0	95	13	14	0	15
CR-P-205-319-96	14	15	18	17	17	15	80	75	2	2	98	10	8	50	11
CR-P-215-127-96	12	11	13	14	12	15	85	74	3	2	80	10	10	50	16
CR-P-224-226-95	11	11	7	8	8	30	80	39	1	0	95	14	13	10	14
CR-P-234-216-96	14	11	14	12	15	80	20	76	0	0	90	14	16	0	16
CR-P-240-225-95	15	12	17	15	11	35	92	105	6	5	80	10	7	50	18
CR-P-242-224-96	16	16	18	16	18	10	65	72	3	0	95	13	10	0	15
CR-P-243-333-96	16	15	18	18	17	35	45	130	9	3	85	11	7	50	13
CR-P-249-103-96	7	10	7	11	8	50	86	31	3	0	40	14	8	35	12
CR-P-249-113-96	5	7	6	11	2	50	85	15	0	0	38	9	9	35	9
CR-P-260-210-96	15	10	10	15	12	65	50	43	2	0	70	9	5	35	15
CR-P-260-212-95	13	13	10	16	13	15	20	43	1	0	100	16	6	30	16
CR-P-263-332-96	9	10	8	17	0	45	30	64	0	0	100	11	10	10	9
CR-P-270-104-95	13	15	12	12	15	10	95	59	1	1	95	17	5	40	17
CR-P-274-104-96	8	11	11	12	11	35	80	51	4	3	65	7	8	50	15
CR-P-280-340-96	13	14	17	18	16	40	25	120	4	5	98	10	7	50	17
CR-P-281-127-95	11	13	11	11	13	20	85	58	0	0	90	14	5	50	13
CR-P-284-328-96	17	16	19	19	17	27	78	120	13	6	95	16	4	35	13
CR-P-294-124-95	13	11	12	11	11	30	75	50	1	1	90	8	11	0	15
CR-P-295-128-96	6	10	6	11	6	90	20	20	0	0	90	8	4	0	14
CR-P-318-338-96	18	19	18	15	18	10	90	53	1	1	90	14	8	45	17
CR-P-323-326-96	12	14	17	18	17	34	60	63	2	1	95	11	10	10	16
CR-P-330-201-96	16	18	10	12	17	15	95	42	1	0	80	15	8	50	16
CR-P-330-229-96	16	15	16	15	16	30	20	103	2	2	90	14	13	0	7
CR-P-341-121-96	17	18	11	13	18	10	90	50	0	0	95	12	7	50	17
CR-P-344-219-96	16	17	8	12	17	50	70	43	0	4	100	17	14	0	7
CR-P-345-321-96	19	18	19	19	19	10	45	141	0	0	98	17	17	0	15
CR-P-362-302-95	17	16	15	17	16	15	55	70	1	0	95	17	17	20	17
CR-P-362-304-95	18	18	17	14	19	5	85	76	0	0	90	15	16	10	11
CR-P-362-310-96	13	11	14	10	13	23	85	92	21	1	80	7	7	50	11
CR-P-362-317-95	7	9	13	16	14	10	81	52	2	0	90	13	7	40	16
CR-P-363-212-96	16	9	18	16	17	60	45	82	2	6	90	10	13	50	16

Table 5 (cont.). Physical habitat data for Maryland Biological Stream Survey sites in Carroll County, 1994-1997.

Site	Instream Habitat[1]	Epifaunal Substrate[1]	Velocity/Depth Diversity[1]	Pool Quality[1]	Riffle Quality[1]	Percent Embeddedness[1]	Percent Shading[1]	Maximum Depth (cm)[1]	Number of Woody Debris	Number of Rootwads	Percent Channel Flow[1]	Channel Alteration[1]	Bank Stability[1]	Riparian Width (m)[1]	Aesthetic Rating[1]
CR-P-363-230-96	16	16	17	18	17	60	79	107	5	1	98	10	6	2	16
CR-P-365-219-96	11	13	13	14	14	25	10	93	0	0	95	10	6	0	15
CR-P-374-343-96	11	11	14	15	12	25	35	125	0	2	95	17	6	0	14
CR-P-376-104-96	18	18	15	16	17	20	95	54	0	1	50	17	16	6	10
CR-P-376-119-96	15	15	14	17	16	15	95	82	0	1	65	15	18	0	6
CR-P-379-123-96	6	6	11	12	8	80	90	53	0	0	85	15	15	0	14
CR-P-398-222-95	17	18	15	18	15	10	85	91	3	1	95	16	5	50	17
CR-P-400-144-96	8	11	6	1	6	80	4	15	0	0	90	5	8	0	7
CR-P-402-121-95	17	18	15	16	15	5	90	66	0	1	95	11	7	0	16
CR-P-403-112-96	13	10	10	7	13	10	70	23	2	0	80	14	14	1	11
CR-P-406-102-96	11	11	10	11	11	35	70	43	0	0	90	14	8	0	14
CR-P-409-320-96	9	10	17	19	1	45	60	88	1	2	100	16	12	0	13
CR-P-415-103-96	12	5	7	15	10	90	100	22	8	0	65	15	14	4	19
CR-P-419-214-95	14	18	15	14	17	25	60	97	4	2	95	15	11	0	16
CR-P-419-227-96	16	17	16	16	16	15	69	120	7	2	60	9	7	14	16
CR-P-434-138-96	6	5	6	11	6	80	70	27	4	0	75	2	1	50	3
CR-P-999-323-95	18	17	15	14	18	10	80	55	2	0	95	16	10	50	16
CR-P-999-323-96	19	15	18	18	19	15	85	88	4	1	90	14	15	6	15
FR-P-474-302-96	11	11	18	17	18	65	35	85	3	1	99	16	7	0	16
HO-P-036-314-95	14	11	8	18	0	60	75	85	3	0	85	13	5	50	15
HO-P-108-313-95	15	15	18	18	17	30	40	122	5	0	90	11	10	0	18
HO-P-151-222-96	18	13	10	11	16	72	35	61	5	0	65	11	13	0	15
HO-P-244-310-95	13	14	17	17	17	25	18	71	1	0	95	8	6	0	12

[1] MBSS Qualitative Habitat Metric - See Appendix B for Guidance

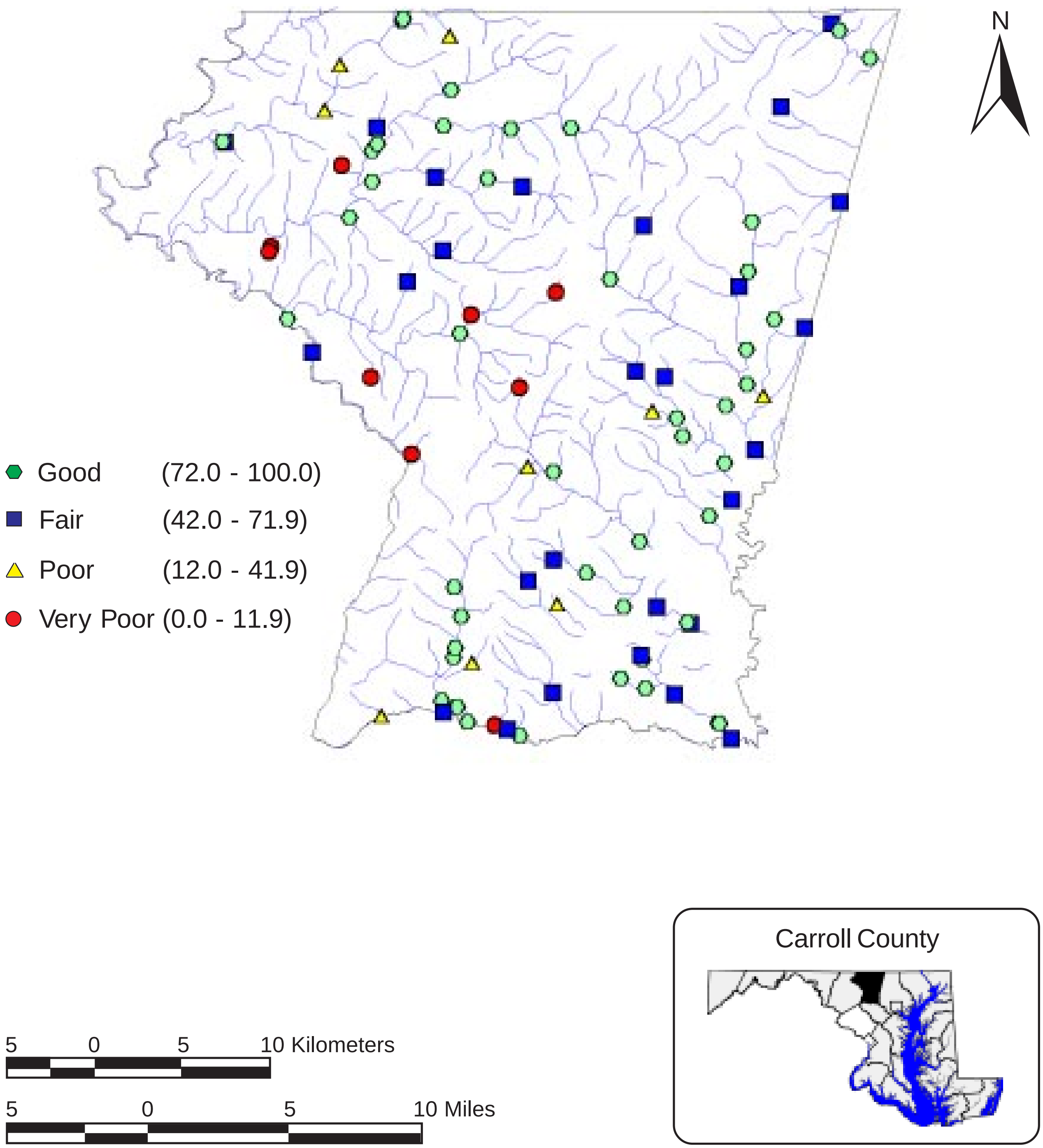

Figure 5. Stream ecological conditions based on the Physical Habitat Index (PHI) at Maryland Biological Stream Survey sites in Carroll County, 1994-1997.

Table 6. Fish Index of Biotic Integrity (F-IBI), Benthic Macroinvertebrate Index of Biotic Integrity (B-IBI), and Physical Habitat Index (PHI) scores at Maryland Biological Stream Survey sites in Carroll County, 1994-1997.

Site	Stream Name	F-IBI	B-IBI	PHI
BA-P-191-211-96	Murphy Run	4.11	3.4	71.41
CR-P-000-938-97	Ut Conewago Cr		3.4	
CR-P-000-939-97	Ut Conewago Cr		4.1	
CR-P-000-940-97	Ut Conewago Cr		3.2	
CR-P-003-316-95	Piney Branch	4.11	4.1	50.87
CR-P-013-108-96	Un Trib To Piney Cr		3.4	35.43
CR-P-019-201-96	Bear Br	3.29	3.2	88.30
CR-P-019-248-96	Bear Br	1.29	2.3	58.96
CR-P-020-208-96	Un Trib To Liberty Res	3.89	1.7	68.83
CR-P-021-329-96	Sam's Cr	2.71	1.0	61.31
CR-P-026-109-96	Un Trib To Gillis Fls	4.11	3.2	77.61
CR-P-035-216-96	Silver Run	4.14	1.0	93.56
CR-P-038-227-95	W Br Patapsco R	2.78	2.1	74.24
CR-P-047-316-96	Gunpowder Fls	4.33	3.4	94.15
CR-P-050-106-95	Ut Beaver Run	2.78	4.1	55.45
CR-P-070-314-96	Trib To Little Fls Run	4.33	3.2	67.95
CR-P-077-309-95	N Br Patapsco R	4.56	3.7	84.47
CR-P-079-209-96	Middle Run	4.78	2.8	92.21
CR-P-084-309-96	Morgan Run	3.89	3.4	86.50
CR-P-086-313-96	Gillis Fls	4.56	2.1	92.21
CR-P-086-325-96	Gillis Fls	3.89	1.4	84.47
CR-P-094-349-96	Turkey Foot Run	4.43	1.7	91.91
CR-P-112-122-95	Ut Morgan Run		3.7	44.24
CR-P-115-111-95	Ut Liberty Reservoir	4.11	3.9	87.87
CR-P-116-316-96	Piney Cr	3.00	1.4	70.14
CR-P-116-327-96	Piney Cr	3.29	1.2	79.67
CR-P-120-232-96	Patapsco R	4.56	2.3	92.78
CR-P-138-116-95	Ut Gillis Falls		4.1	25.52
CR-P-142-324-96	Piney Cr	3.86	2.8	31.34
CR-P-143-218-95	Ut Morgan Run	4.33	3.7	25.91
CR-P-149-118-96	Roaring Run	3.89	3.9	80.64
CR-P-152-302-96	North Br Patapsco R		2.6	
CR-P-152-318-95	N Br Patapsco R	3.67	2.8	51.38
CR-P-156-314-96	Piney Cr	5.00	2.8	75.85
CR-P-156-361-96	Piney Cr	4.43	2.6	92.18
CR-P-158-123-96	Priestland Br		1.4	7.00
CR-P-162-207-96	Meadow Br	2.14	1.7	73.45
CR-P-166-221-95	Little Morgan Run	3.89	4.3	73.93
CR-P-171-306-96	Gunpowder Fls	4.11	3.4	75.02
CR-P-175-113-95	Ut Little Morgan Run	4.33	4.3	57.96
CR-P-180-124-96	Un Trib To Big Pipe Cr	3.57	3.2	43.73
CR-P-193-311-96	Beaver Run	4.11	2.8	82.49
CR-P-205-319-96	Big Pipe	4.71	3.0	88.08
CR-P-215-127-96	Un Trib To Liberty Res	3.89	2.3	67.50
CR-P-224-226-95	Middle Run	3.89	3.9	16.47
CR-P-227-305-96	Patapsco R		3.7	
CR-P-234-216-96	Un Trib To Piney Run	3.89	3.2	48.31
CR-P-240-225-95	Ut N Br Patapsco R	4.11	3.2	
CR-P-242-224-96	East Br Patapsco	3.89	2.1	86.50

Table 6 (cont.). Fish Index of Biotic Integrity (F-IBI), Benthic Macroinvertebrate Index of Biotic Integrity (B-IBI), and Physical Habitat Index (PHI) scores at Maryland Biological Stream Survey sites in Carroll County, 1994-1997.

Site	Stream Name	F-IBI	B-IBI	PHI
CR-P-243-333-96	Big Pipe Cr	5.00	2.3	92.06
CR-P-249-103-96	Un Trib To Big Pipe		2.3	7.99
CR-P-249-113-96	Un Trib To Big Pipe		2.6	2.48
CR-P-260-210-96	Beaver Run	4.56	2.6	34.04
CR-P-260-212-95	Beaver Run	4.78	3.4	46.78
CR-P-263-332-96	Little Pipe Cr	2.71	2.3	4.23
CR-P-270-104-95	Cranberry Branch	4.11	3.7	69.70
CR-P-274-104-96	Roop Br	1.00	2.1	48.82
CR-P-280-340-96	Big Pipe Cr	4.71	3.4	93.56
CR-P-281-127-95	Ut Patapsco R	4.33	2.8	39.26
CR-P-284-328-96	Big Pipe	3.86	3.7	98.02
CR-P-294-124-95	Aspen Run	4.33	3.0	50.35
CR-P-295-128-96	Copps Br		1.4	3.41
CR-P-318-338-96	Bear Br	4.43	3.4	92.78
CR-P-323-326-96	Big Pipe	5.00	3.0	77.46
CR-P-330-201-96	East Br Patapsco	3.67	3.2	67.50
CR-P-330-229-96	East Br Patapsco	4.78	2.6	82.19
CR-P-341-121-96	Un Trib To Little Morgan Run	3.22	3.0	76.89
CR-P-344-219-96	East Br Of Patapsco	4.33	3.0	76.15
CR-P-345-321-96	Morgan Run	4.11	2.1	92.21
CR-P-362-302-95	Piney Run	4.56	3.7	80.00
CR-P-362-304-95	Piney Run	4.56	3.9	88.08
CR-P-362-310-96	North Br Patapsco R	3.89	1.7	60.54
CR-P-362-317-95	Piney Run	4.78	4.1	42.23
CR-P-363-212-96	Piney Run	4.56	1.9	96.68
CR-P-363-230-96	Piney Run	3.44	3.0	80.32
CR-P-365-219-96	Meadow Br	3.86	2.6	48.82
CR-P-374-343-96	Bear Br	4.43	3.2	62.86
CR-P-376-104-96	Un Trib To Piney Run	3.00	2.6	83.92
CR-P-376-119-96	Un Trib To Piney Run	3.00	3.0	71.82
CR-P-379-123-96	Morgan Run		1.7	8.62
CR-P-398-222-95	Gillis Falls	3.89	3.9	84.47
CR-P-400-144-96	Un Trib To Big Pipe Cr		1.2	3.69
CR-P-402-121-95	Deep Run	3.89	3.2	84.73
CR-P-403-112-96	Un Trib To Graves Run		3.0	43.23
CR-P-406-102-96	Un Trib To Piney Cr	3.00	1.4	27.92
CR-P-409-320-96	North Br Patapsco R	3.44	4.3	27.11
CR-P-415-103-96	Un Trib To Piney Run		3.7	14.33
CR-P-419-214-95	Gillis Falls	4.33	2.6	84.73
CR-P-419-227-96	Gillis Fls	3.89	1.7	88.92
CR-P-434-138-96	Un Trib To Sam's Cr		2.1	2.48
CR-P-999-323-95	Beaver Run	3.89	2.6	85.51
CR-P-999-323-96	Beaver Run	3.89	4.1	93.44
FR-P-474-302-96	Sam's Cr	1.57	1.7	72.64
HO-P-036-314-95	Patapsco R	3.00	3.7	7.99
HO-P-108-313-95	Patapsco R	4.11	3.4	81.59
HO-P-151-222-96	Patapsco R	4.33	1.9	52.81
HO-P-244-307-96	Patapsco R		2.1	
HO-P-244-310-95	Patapsco R	4.11	3.0	71.82

Table 7. Water chemistry data collected at Maryland Biological Stream Survey sites in Carroll County, 1994-1997.

Site	pH	Conductivity (µS/cm)	Acid Neutralizing Capacity (µeq/L)	Nitrate (mg/L)	Sulfate (mg/L)	Dissolved Oxygen (mg/L)	Dissolved Organic Carbon (mg/L)
BA-P-191-211-96	7.76	0.236	512.20	5.252	5.635	9.90	1.10
CR-P-000-938-97	7.37	0.090	359.70	2.000	4.480	7.80	1.70
CR-P-000-939-97	6.87	0.158	356.40	6.038	7.752	8.80	1.10
CR-P-000-940-97	7.31	0.151	373.10	6.743	7.041	8.00	0.80
CR-P-003-316-95	7.26	0.136	372.91	4.703	5.380	8.30	
CR-P-013-108-96	6.37	0.077	180.30	3.197	5.327	12.20	1.00
CR-P-019-201-96	7.25	0.196	602.40	5.341	7.739	8.50	1.00
CR-P-019-248-96	7.38	0.223	801.70	5.193	8.803	8.70	2.70
CR-P-020-208-96	7.44	0.198	517.40	2.582	6.169	8.90	1.60
CR-P-021-329-96	8.57	0.289	1560.90	5.358	13.765	9.60	1.60
CR-P-026-109-96	6.89	0.128	226.80	4.614	4.278	10.40	1.00
CR-P-035-216-96	7.55	0.190	735.90	3.246	11.171	9.40	3.00
CR-P-038-227-95	8.11	0.482	1829.80	6.283	13.845	7.80	2.00
CR-P-047-316-96	8.90	0.144	499.90	3.011	5.915	11.10	1.00
CR-P-050-106-95	7.35	0.266	561.95	9.066	6.119	9.20	2.00
CR-P-070-314-96	7.61	0.156	528.80	3.222	5.913	9.60	1.30
CR-P-077-309-95	7.69	0.171	626.88	4.686	5.924	9.20	2.00
CR-P-079-209-96	7.11	0.146	303.60	4.046	5.700	8.30	1.40
CR-P-084-309-96	7.57	0.150	392.20	4.382	5.736	9.30	1.00
CR-P-086-313-96	7.41	0.127	273.20	3.858	5.367	9.20	0.90
CR-P-086-325-96	7.23	0.125	262.70	4.111	5.269	9.60	1.00
CR-P-094-349-96	7.90	0.401	2517.70	5.557	16.094	9.40	0.80
CR-P-112-122-95	7.20	0.185	598.49	3.011	8.001	8.50	
CR-P-115-111-95	7.41	0.206	803.41	3.492	5.821	8.30	
CR-P-116-316-96	7.94	0.233	889.70	4.030	20.472	9.60	3.10
CR-P-116-327-96	7.83	0.247	895.50	4.019	20.361	7.50	2.60
CR-P-120-232-96	7.34	0.242	431.90	3.897	8.424	9.80	1.40
CR-P-138-116-95	6.98	0.160	303.92	8.211	6.129	8.10	2.00
CR-P-142-324-96	7.54	0.228	762.50	2.981	19.085	10.70	6.60
CR-P-143-218-95	7.45	0.110	443.96	3.473	4.331	9.10	2.00
CR-P-149-118-96	7.11	0.220	353.70	4.913	5.786	8.90	1.20
CR-P-152-302-96	7.40	0.223	500.70	4.763	8.522		2.00
CR-P-152-318-95	7.46	0.183	635.35	4.600	7.304	8.10	1.00
CR-P-156-314-96	7.42	0.198	604.70	4.571	17.836	9.30	1.80
CR-P-156-361-96	7.35	0.195	605.00	4.602	17.847	9.30	1.70
CR-P-158-123-96	7.62	0.710	2713.50	23.729	44.717	8.10	2.30
CR-P-162-207-96	7.69	0.322	1342.30	8.098	21.631	9.10	1.70
CR-P-166-221-95	7.10	0.184	314.86	4.038	3.561	9.53	
CR-P-171-306-96	8.06	0.151	518.00	3.296	5.978	9.70	1.30
CR-P-175-113-95	7.19	0.123	515.21	2.764	5.369	9.00	2.00
CR-P-180-124-96	7.16	0.171	536.30	2.134	19.634	8.00	3.50
CR-P-193-311-96	7.42	0.189	387.60	4.451	6.525	8.80	1.10
CR-P-205-319-96	7.57	0.169	564.10	3.478	9.528	10.40	1.20
CR-P-215-127-96	7.08	0.154	355.70	4.755	10.669	10.30	1.20
CR-P-224-226-95	7.23	0.166	352.62	4.844	4.400	7.40	1.00
CR-P-227-305-96	7.46	0.205	512.00	5.842	7.026		2.00
CR-P-234-216-96	7.07	0.168	367.00	4.708	5.052	9.20	1.20
CR-P-240-225-95						8.20	

Table 7 (cont.). Water chemistry data collected at Maryland Biological Stream Survey sites in Carroll County, 1994-1997.

Site	pH	Conductivity (µS/cm)	Acid Neutralizing Capacity (µeq/L)	Nitrate (mg/L)	Sulfate (mg/L)	Dissolved Oxygen (mg/L)	Dissolved Organic Carbon (mg/L)
CR-P-242-224-96	7.64	0.172	389.50	5.743	6.231	9.10	1.20
CR-P-243-333-96	7.24	0.204	647.10	3.613	7.990	9.10	2.20
CR-P-249-103-96	6.95	0.195	402.40	4.435	32.351	9.00	2.00
CR-P-249-113-96	7.09	0.253	567.20	6.414	35.343	5.90	2.20
CR-P-260-210-96	7.33	0.268	568.30	5.615	8.669	8.60	1.50
CR-P-260-212-95	7.20	0.177	482.31	5.659	5.910	8.10	1.00
CR-P-263-332-96	7.78	0.472	2022.90	6.901	22.360	12.40	2.80
CR-P-270-104-95	7.54	0.176	638.59	8.138	6.250	8.30	1.00
CR-P-274-104-96	7.75	0.359	1739.20	10.253	19.827	8.95	1.00
CR-P-280-340-96	7.35	0.178	628.70	3.521	7.942	8.50	2.10
CR-P-281-127-95	7.47	0.169	598.28	4.952	5.336	5.70	2.00
CR-P-284-328-96	7.53	0.163	558.30	3.534	8.197	7.50	1.30
CR-P-294-124-95	7.06	0.231	295.56	6.936	5.892	8.86	
CR-P-295-128-96	7.80	0.676	2411.50	4.012	13.412	5.90	1.50
CR-P-318-338-96	7.44	0.207	673.80	4.666	10.662	7.90	1.80
CR-P-323-326-96	7.69	0.169	563.90	3.536	8.940	10.70	1.40
CR-P-330-201-96	7.93	0.190	407.20	6.403	6.711	9.20	1.20
CR-P-330-229-96	7.62	0.194	419.50	6.496	6.613	10.20	1.20
CR-P-341-121-96	7.41	0.225	438.10	4.439	9.844	9.50	1.10
CR-P-344-219-96	7.33	0.165	332.20	5.833	6.221	10.40	1.00
CR-P-345-321-96	7.94	0.151	352.00	4.024	5.451	9.00	1.10
CR-P-362-302-95	7.48	0.178	695.06	2.171	10.173	9.20	2.00
CR-P-362-304-95	7.51	0.191	573.40	2.172	10.185	8.80	2.00
CR-P-362-310-96	7.29	0.204	567.10	2.166	9.066	7.90	2.40
CR-P-362-317-95	7.35	0.179	694.59	2.033	8.317	7.60	2.00
CR-P-363-212-96	7.30	0.177	456.00	1.848	6.755	7.90	2.80
CR-P-363-230-96	7.25	0.142	438.20	1.840	5.290	7.80	3.10
CR-P-365-219-96	7.98	0.262	1078.70	5.013	10.980	8.50	1.10
CR-P-374-343-96	7.29	0.184	634.10	4.825	8.451	9.90	1.80
CR-P-376-104-96	7.71	0.359	1282.70	3.256	7.756	9.10	1.30
CR-P-376-119-96	7.77	0.344	1321.80	3.082	7.439	9.60	1.40
CR-P-379-123-96	6.65	0.144	202.90	9.010	4.802	9.50	0.70
CR-P-398-222-95	7.09	0.112	312.08	4.162	3.430	8.20	4.00
CR-P-400-144-96	7.44	0.877	1382.90	2.649	27.209	6.70	4.70
CR-P-402-121-95	7.15	0.184	292.33	6.064	10.715	8.70	1.00
CR-P-403-112-96	6.96	0.127	243.10	5.060	2.648	10.60	0.60
CR-P-406-102-96	7.27	0.252	848.00	5.536	28.486	7.10	3.00
CR-P-409-320-96	7.42	0.209	518.30	5.439	6.820	9.60	1.00
CR-P-415-103-96		0.084	118.80	3.366	3.618	9.40	0.90
CR-P-419-214-95	7.27	0.117	347.53	4.468	3.849	8.60	2.00
CR-P-419-227-96	7.37	0.136	297.90	4.488	5.146	9.60	1.70
CR-P-434-138-96	7.08	0.193	717.10	5.795	7.010	7.70	2.10
CR-P-999-323-95	7.58	0.165	413.21	4.812	4.781	9.20	2.00
CR-P-999-323-96	7.36	0.191	366.70	4.919	5.933	9.40	1.00
FR-P-474-302-96	8.32	0.345	1948.70	5.432	24.018	9.00	2.10
HO-P-036-314-95	7.50	0.146	425.34	4.189	5.114	9.80	2.00
HO-P-108-313-95	7.38	0.158	574.14	4.330	5.446	9.40	2.00
HO-P-151-222-96	7.61	0.259	488.30	4.061	9.896	8.90	2.00

Table 7 (cont.). Water chemistry data collected at Maryland Biological Stream Survey sites in Carroll County, 1994-1997.

Site	pH	Conductivity (µS/cm)	Acid Neutralizing Capacity (µeq/L)	Nitrate (mg/L)	Sulfate (mg/L)	Dissolved Oxygen (mg/L)	Dissolved Organic Carbon (mg/L)
HO-P-244-307-96	7.28	0.177	360.50	4.051	7.011		1.10
HO-P-244-310-95	7.54	0.147	472.95	4.276	5.336	7.70	2.00

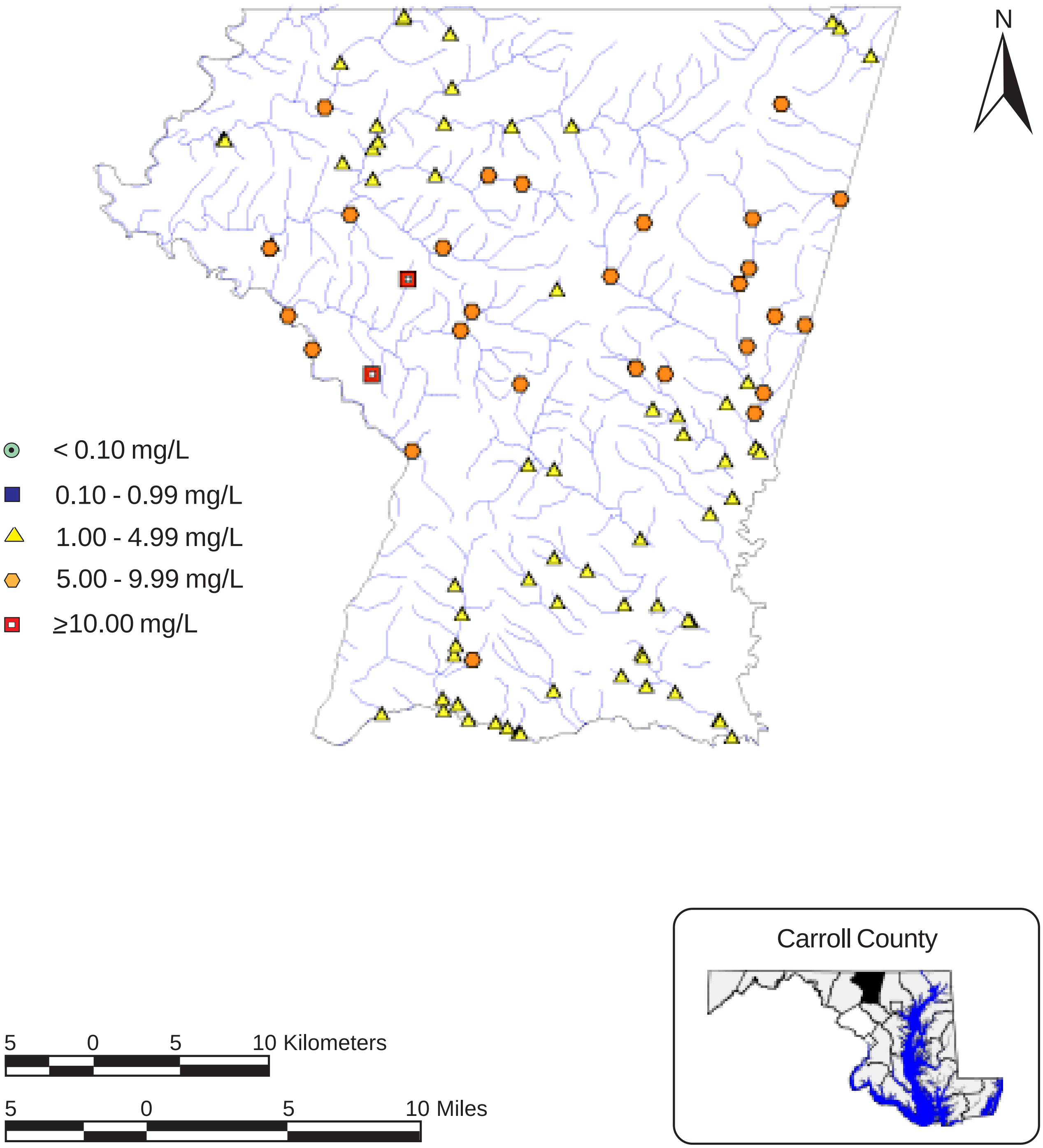

Figure 6. Nitrate-nitrogen concentrations (mg/L) at Maryland Biological Stream Survey sites in Carroll County, 1994-1997.

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Appendix A. Summary of the types of data collected at Maryland Biological Stream Survey sites in Carroll County, 1994-1997. Abbreviations used are as follows: F-IBI - Fish Index of Biotic Integrity; B-IBI Benthic Macroinvertebrate Index of Biotic Integrity; Fam.IBI - Family-Level Benthic Macroinvertebrate Index of Biotic Integrity; PHI - Physical Habitat Index.

Site	Stream Name	Fish	Benthic Macroinvertebrate	Herpetofauna	Habitat	Water Chemistry	F-IBI	B-IBI	Fam. IBI	PHI
BA-P-191-211-96	*Murphy Run*	X	X	X	X	X	X	X		X
CR-P-000-938-97	*Ut Conewago Cr*	X	X	X	X	X		X		
CR-P-000-939-97	*Ut Conewago Cr*	X	X	X	X	X		X		
CR-P-000-940-97	*Ut Conewago Cr*	X	X	X	X	X		X		
CR-P-003-316-95	*Piney Branch*	X	X	X	X	X	X	X		X
CR-P-013-108-96	*Un Trib To Piney Cr*	X	X	X	X	X		X		X
CR-P-019-201-96	*Bear Br*	X	X	X	X	X	X	X		X
CR-P-019-248-96	*Bear Br*	X	X	X	X	X	X	X		X
CR-P-020-208-96	*Un Trib To Liberty Res*	X	X	X	X	X	X	X		X
CR-P-021-329-96	*Sam's Cr*	X	X	X	X	X	X	X		X
CR-P-026-109-96	*Un Trib To Gillis Fls*	X	X	X	X	X	X	X		X
CR-P-035-216-96	*Silver Run*	X	X	X	X	X	X	X		X
CR-P-038-227-95	*W Br Patapsco R*	X	X	X	X	X	X	X		X
CR-P-047-316-96	*Gunpowder Fls*	X	X	X	X	X	X	X		X
CR-P-050-106-95	*Ut Beaver Run*	X	X	X	X	X	X	X		X
CR-P-070-314-96	*Trib To Little Fls Run*	X	X	X	X	X	X	X		X
CR-P-077-309-95	*N Br Patapsco R*	X	X	X	X	X	X	X		X
CR-P-079-209-96	*Middle Run*	X	X	X	X	X	X	X		X
CR-P-084-309-96	*Morgan Run*	X	X	X	X	X	X	X		X
CR-P-086-313-96	*Gillis Fls*	X	X	X	X	X	X	X		X
CR-P-086-325-96	*Gillis Fls*	X	X	X	X	X	X	X		X
CR-P-094-349-96	*Turkey Foot Run*	X	X	X	X	X	X	X		X
CR-P-112-122-95	*Ut Morgan Run*	X	X	X	X	X		X		X
CR-P-115-111-95	*Ut Liberty Reservoir*	X	X	X	X	X	X	X		X
CR-P-116-316-96	*Piney Cr*	X	X	X	X	X	X	X		X
CR-P-116-327-96	*Piney Cr*	X	X	X	X	X	X	X		X
CR-P-120-232-96	*Patapsco R*	X	X	X	X	X	X	X		X
CR-P-138-116-95	*Ut Gillis Falls*	X	X	X	X	X		X		X
CR-P-142-324-96	*Piney Cr*	X	X	X	X	X	X	X		X
CR-P-143-218-95	*Ut Morgan Run*	X	X	X	X	X	X	X		X
CR-P-149-118-96	*Roaring Run*	X	X	X	X	X	X	X		X
CR-P-152-302-96	*North Br Patapsco R*		X			X		X		
CR-P-152-318-95	*N Br Patapsco R*	X	X	X	X	X	X	X		X
CR-P-156-314-96	*Piney Cr*	X	X	X	X	X	X	X		X
CR-P-156-361-96	*Piney Cr*	X	X	X	X	X	X	X		X

Appendix A (cont.). Summary of the types of data collected at Maryland Biological Stream Survey sites in Carroll County, 1994-1997. Abbreviations used are as follows: F-IBI - Fish Index of Biotic Integrity; B-IBI - Benthic Macroinvertebrate Index of Biotic Integrity; Fam. IBI - Family-Level Benthic Macroinvertebrate Index of Biotic Integrity; PHI - Physical Habitat Index.

Site	Stream Name	Fish	Benthic Macroinvertebrate	Herpetofauna	Habitat	Water Chemistry	F-IBI	B-IBI	Fam. IBI	PHI
CR-P-158-123-96	***Priestland Br***	X	X	X	X	X		X		X
CR-P-162-207-96	***Meadow Br***	X	X	X	X	X	X	X		X
CR-P-166-221-95	***Little Morgan Run***	X	X	X	X	X	X	X		X
CR-P-171-306-96	***Gunpowder Fls***	X	X	X	X	X	X	X		X
CR-P-175-113-95	***Ut Little Morgan Run***	X	X	X	X	X	X	X		X
CR-P-180-124-96	***Un Trib To Big Pipe Cr***	X	X	X	X	X	X	X		X
CR-P-193-311-96	***Beaver Run***	X	X	X	X	X	X	X		X
CR-P-205-319-96	***Big Pipe***	X	X	X	X	X	X	X		X
CR-P-215-127-96	***Un Trib To Liberty Res***	X	X	X	X	X	X	X		X
CR-P-224-226-95	***Middle Run***	X	X	X	X	X	X	X		X
CR-P-227-305-96	***Patapsco R***		X			X		X		
CR-P-234-216-96	***Un Trib To Piney Run***	X	X	X	X	X	X	X		X
CR-P-240-225-95	***Ut N Br Patapsco R***	X	X	X	X	X	X	X		
CR-P-242-224-96	***East Br Patapsco***	X	X	X	X	X	X	X		X
CR-P-243-333-96	***Big Pipe Cr***	X	X	X	X	X	X	X		X
CR-P-249-103-96	***Un Trib To Big Pipe***	X	X	X	X	X		X		X
CR-P-249-113-96	***Un Trib To Big Pipe***	X	X	X	X	X		X		X
CR-P-260-210-96	***Beaver Run***	X	X	X	X	X	X	X		X
CR-P-260-212-95	***Beaver Run***	X	X	X	X	X	X	X		X
CR-P-263-332-96	***Little Pipe Cr***	X	X	X	X	X	X	X		X
CR-P-270-104-95	***Cranberry Branch***	X	X	X	X	X	X	X		X
CR-P-274-104-96	***Roop Br***	X	X	X	X	X	X	X		X
CR-P-280-340-96	***Big Pipe Cr***	X	X	X	X	X	X	X		X
CR-P-281-127-95	***Ut Patapsco R***	X	X	X	X	X	X	X		X
CR-P-284-328-96	***Big Pipe***	X	X	X	X	X	X	X		X
CR-P-294-124-95	***Aspen Run***	X	X	X	X	X	X	X		X
CR-P-295-128-96	***Copps Br***	X	X	X	X	X		X		X
CR-P-318-338-96	***Bear Br***	X	X	X	X	X	X	X		X
CR-P-323-326-96	***Big Pipe***	X	X	X	X	X	X	X		X
CR-P-330-201-96	***East Br Patapsco***	X	X	X	X	X	X	X		X
CR-P-330-229-96	***East Br Patapsco***	X	X	X	X	X	X	X		X
CR-P-341-121-96	***Un Trib To Little Morgan Run***	X	X	X	X	X	X	X		X
CR-P-344-219-96	***East Br Of Patapsco***	X	X	X	X	X	X	X		X
CR-P-345-321-96	***Morgan Run***	X	X	X	X	X	X	X		X
CR-P-362-302-95	***Piney Run***	X	X	X	X	X	X	X		X

Appendix A (cont.). Summary of the types of data collected at Maryland Biological Stream Survey sites in Carroll County, 1994-1997. Abbreviations used are as follows: F-IBI - Fish Index of Biotic Integrity; B-IBI - Benthic Macroinvertebrate Index of Biotic Integrity; Fam. IBI - Family-Level Benthic Macroinvertebrate Index of Biotic Integrity; PHI - Physical Habitat Index.

Site	Stream Name	Fish	Benthic Macroinvertebrate	Herpetofauna	Habitat	Water Chemistry	F-IBI	B-IBI	Fam. IBI	PHI
CR-P-362-304-95	*Piney Run*	X	X	X	X	X	X	X		X
CR-P-362-310-96	*North Br Patapsco R*	X	X	X	X	X	X	X		X
CR-P-362-317-95	*Piney Run*	X	X	X	X	X	X	X		X
CR-P-363-212-96	*Piney Run*	X	X	X	X	X	X	X		X
CR-P-363-230-96	*Piney Run*	X	X	X	X	X	X	X		X
CR-P-365-219-96	*Meadow Br*	X	X	X	X	X	X	X		X
CR-P-374-343-96	*Bear Br*	X	X	X	X	X	X	X		X
CR-P-376-104-96	*Un Trib To Piney Run*	X	X	X	X	X	X	X		X
CR-P-376-119-96	*Un Trib To Piney Run*	X	X	X	X	X	X	X		X
CR-P-379-123-96	*Morgan Run*	X	X	X	X	X		X		X
CR-P-398-222-95	*Gillis Falls*	X	X	X	X	X	X	X		X
CR-P-400-144-96	*Un Trib To Big Pipe Cr*	X	X	X	X	X		X		X
CR-P-402-121-95	*Deep Run*	X	X	X	X	X	X	X		X
CR-P-403-112-96	*Un Trib To Graves Run*	X	X	X	X	X		X		X
CR-P-406-102-96	*Un Trib To Piney Cr*	X	X	X	X	X	X	X		X
CR-P-409-320-96	*North Br Patapsco R*	X	X	X	X	X	X	X		X
CR-P-415-103-96	*Un Trib To Piney Run*	X	X	X	X	X		X		X
CR-P-419-214-95	*Gillis Falls*	X	X	X	X	X	X	X		X
CR-P-419-227-96	*Gillis Fls*	X	X	X	X	X	X	X		X
CR-P-434-138-96	*Un Trib To Sam's Cr*	X	X	X	X	X		X		X
CR-P-999-323-95	*Beaver Run*	X	X	X	X	X	X	X		X
CR-P-999-323-96	*Beaver Run*	X	X	X	X	X	X	X		X
FR-P-474-302-96	*Sam's Cr*	X	X	X	X	X	X	X		X
HO-P-036-314-95	*Patapsco R*	X	X	X	X	X	X	X		X
HO-P-108-313-95	*Patapsco R*	X	X	X	X	X	X	X		X
HO-P-151-222-96	*Patapsco R*	X	X	X	X	X	X	X		X
HO-P-244-307-96	*Patapsco R*		X			X		X		
HO-P-244-310-95	*Patapsco R*	X	X	X	X	X	X	X		X

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Appendix B. Physical habitat condition measured by the Maryland Biological Stream Survey, 1994-1997. All variables rated on a scale of 0 (poor) to 20 (optimal) unless otherwise noted.

SUBSTRATE AND INSTREAM COVER

Instream Habitat **is rated according to the perceived value of habitat to the fish community. Higher scores are assigned to sites with a variety of habitat types and particle sizes. In addition, higher scores are assigned to sites with a high degree of uneven substrate, including logs and rootwads. In streams where substrate types are favorable but flows are so low that fish are essentially precluded from using the habitat, low scores are assigned. If none of the habitat within a segment is useable by fish, a score of zero is assigned.**

Epifaunal Substrate **is rated based on the amount and variety of hard, stable substrates usable by benthic macroinvertebrates. Because they inhibit colonization, flocculent materials or fine sediments surrounding otherwise good substrates are assigned low scores. Scores are also reduced when substrates are less stable.**

Velocity/Depth Diversity **is rated based on the variety of velocity/ depth regimes present at a site (slow-shallow, slow-deep, fast-shallow, and fast-deep). As with embeddedness, this metric varies by stream gradient.**

Pool/Glide/Eddy Quality **is rated based on the variety and spatial complexity of slow or still water habitat within the sample segment. In high-gradient streams, functionally important slow water habitat may exist in the form of larger eddies. Within a category, higher scores are assigned to segments which have undercut banks, woody debris or other types of cover for fish.**

Riffle/Run Quality **is based on the depth, complexity, and functional importance of riffle/ run habitat in the segment, with highest scores assigned to segments dominated by deeper riffle/ run areas, stable substrates, and a variety of current velocities.**

Embeddedness **is a percentage of surface area of larger particles that is surrounded by fine sediments on the stream bottom. In low gradient streams, embeddedness may be high even in relatively unimpaired watersheds.**

CHANNEL CHARACTER

Channel Alteration **is a measure of large-scale changes in the shape of the stream channel. Channel alteration includes: concrete channels, artificial embankments, obvious straightening of the natural channel, rip-rap, or other structures, as well as recent bar development. Ratings for this metric are based on the presence of artificial structures as well as the existence, extent, and coarseness of point bars, side bars, and mid-channel bars which indicate the degree of flow fluctuations and substrate stability. Evidence of channelization may sometimes be seen in the form of berms that parallel the stream channel.**

Bank Stability **is rated based on the presence/ absence of riparian vegetation and other stabilizing bank materials such as boulders and rootwads, and frequency/ size of erosional areas. Sites with steep slopes are not penalized if banks are composed solely of stable materials.**

Channel Flow Status **is the percentage of the stream channel that has water, with subtractions made for exposed substrates and dewatered areas.**

RIPARIAN CORRIDOR

Shading **is rated based on estimates of the degree and duration of shading at a site during summer, including any effects of shading caused by land forms.**

Appendix B (cont.). Physical habitat condition measured by the Maryland Biological Stream Survey, 1994-1997. All variables rated on a scale of 0 (poor) to 20 (optimal) unless otherwise noted.

Riparian Buffer **is rated according to the size and type of the vegetated riparian buffer zone at the site. Cultivated fields for agriculture that have bare soil to any extent are not considered as riparian buffers. At sites where the buffer width is variable, or direct delivery of storm runoff or sediment to the stream is evident or highly likely, the narrowest representative buffer width in the segment (e.g., 0 if parking lot runoff enters directly to the stream) is measured and recorded even though some of the stream segment may have a well developed riparian buffer.**

AESTHETICS/REMOTENESS

Aesthetics **are rated according to the visual appeal of the site and presence/ absence of human refuse, with highest scores assigned to stream segments with no human refuse and visually outstanding character.**

Remoteness **is rated based on the absence of detectable human activity and difficulty in accessing the segment.**